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# DESCRIPTIVE AND ILLUSTRATED CATALOGUE

OF THE

# HISTOLOGICAL SERIES

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## THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

PREPARED FOR THE MICROSCOPE.

VOLUME II.

STRUCTURE OF THE SKELETON OF VERTEBRATE ANIMALS.

UNIVERSITY COLLEGE LONDON

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# PREFACE.

THE subject of the present Volume is the Structure of the Skeleton of Vertebrate Animals, and contains a description of 945 preparations. Of these, 385 belong to the skeleton of Fishes, 103 to that of Reptiles, 60 to that of Birds, and the remaining 397 to that of Mammalia. When this Volume of the Catalogue was commenced, the number of specimens of the structure of the vertebrate skeleton belonging to the Histological Museum did not exceed 200; the remaining 745 have been prepared during the progress of the work.

The specimens obtained from Reptiles, Birds, and Mammals are all arranged in the same order as those of the Osteological Catalogue of the Museum, but this plan has been departed from in the case of the Fishes, the most highly organized tissue of which the skeleton of any Fish may be composed, having been taken as the guide.

As in the former Volume, each division of the subject is preceded by

a short introduction, directing the attention of the student to the principal points of interest, which the specimens immediately following will be found to exhibit.

The Plates, eighteen in number, contain 432 representations of the most striking specimens; all of which, with one or two exceptions, have been drawn from the Microscope by means of the Camera lucida.

For the sake of comparing the minute structure of the bones of the four great classes of animals, the greater part of the sections have been drawn under two powers, one of 95, the other of 440 diameters, it having been ascertained that the size and arrangement of the lacunæ are frequently of the greatest importance in determining the true nature of fragments of recent and fossil bone, when other characters are wanting.

Royal College of Surgeons, 1855.

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ENDO-SKELETON.

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## ENDO-SKELETON OF BATRACHIA.


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|---|---|
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| *Axolotes marmoratus*, Axolotl | B b 21—B b 23 |
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| *Menopoma* (fossil species) | B b 28—B b 31 |
| *Triton cristatus*, Newt | B b 32—B b 33 |
| *Rana temporaria*, Frog | B b 34—B b 37 |
| *Rana boans*, Bull Frog | B b 38—B b 39 |
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| *Python tigris*, Tiger Boa | B b 45—B b 47 |
| *Coluber natrix*, Common Snake | B b 48 |
| *Anguis fragilis*, Slow-worm | B b 49 |
| *Amphisbæna alba*, Amphisbæna | B b 50 |
| *Coluber Berus*, Viper | B b 51 |
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| *Varanus variegatus*, Monitor Lizard | B b 56—B b 57 |
| *Draco volans*, Flying Lizard | B b 58—B b 61 |
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| | No. of Preparations. |
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| | |
|---|---|
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| *Pelecanus onocrotalus*, Pelican . . . . . | B c 4—B c 5 |
| *Diomedæa exulans*, Albatros . . . . . | B c 6—B c 7 |
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| | |
|---|---|
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| *Ciconia alba*, Stork . . . . . | B c 14—B c 17 |


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| | |
|---|---|
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| *Struthio Camelus*, Ostrich . . . . . | B c 20—B c 26 |
| *Dinornis giganteus*, Dinornis . . . . . | B c 27—B c 28 |
| *Dinornis didiformis* . . . . . | B c 29—B c 30 |
| ———? . . . . . | B c 31 |


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| | |
|---|---|
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## Order SCANSORES.


| | |
|---|---|
| *Psittacus viridis*, Parrot . . . . . | B c 36—B c 37 |

## Order PASSERES.


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|---|---|
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| *Fringilla canaria*, Canary | B c 41—B c 42 |
| *Alauda arvensis*, Lark | B c 43 |
| *Linaria cannabina*, Linnet | B c 44 |
| *Paradisea superba*, Bird of Paradise | B c 45 |


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| | |
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### SPLANCHNO-SKELETON.


| | |
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| *Cygnus olor*, Swan | B c 55 |
| *Fringilla canaria*, Canary | B c 56 |
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# Class MAMMALIA.

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| | |
|---|---|
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| | |
|---|---|
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| | No. of Preparations. |
|---|---|
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| *Petaurus sciuræus*, Petaurist . . . . . | B d 23—B d 24 |
| *Didelphis Virginiana*, Opossum . . . . | B d 25—B d 26 |
| *Dasyurus viverrinus*, Dasyure . . . . . | B d 27—B d 28 |
| *Thylacinus cynocephalus*, Thylacine . . . | B d 29—B d 30 |

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| *Hydrochœrus Capybara*, Capybara . . . | B d 35—B d 36 |
| *Cœlogenys Paca*, Paca . . . . . | B d 37—B d 38 |
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| *Hystrix* . . . . . | B d 41—B d 42 |
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| *Arvicola amphibia*, Water Rat . . . . . | B d 47—B d 48 |
| *Mus Rattus*, Rat . . . . . | B d 49—B d 51 |
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| *Arctomys Marmotta*, Marmot . . . . . | B d 54—B d 55 |
| *Sciurus vulgaris*, Squirrel . . . . . | B d 56—B d 57 |

Order BRUTA.

| | |
|---|---|
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| *Manis pentadactyla*, Manis . . . . . | B d 63—B d 64 |
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|---|---|
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| | |
|---|---|
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| | |
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| *Delphinus* . . . . . | B d 111—B d 112 |
| *Delphinus tursio*, Dolphin . . . . . | B d 113—B d 114 |
| *Delphinus delphis* . . . . . | B d 115—B d 116 |
| *Delphinus phocæna*, Porpoise . . . . | B d 117—B d 122 |
| *Monodon monoceros*, Narwhal . . . . | B d 123—B d 124 |
| *Halicore indicus*, Dugong . . . . . | B d 125—B d 130 |
| *Manatus americanus*, Manatee . . . . | B d 131—B d 134 |


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| | |
|---|---|
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| | |
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| *Hippopotamus amphibius*, Hippopotamus . | B d 167—B d 170 |

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| | |
|---|---|
| *Camelus Bactrianus*, Camel . . . . | B d 171—B d 174 |
| *Auchenia Llama*, Llama . . . . . | B d 175—B d 176 |
| *Moschus moschiferus*, Musk-deer . . . | B d 177—B d 178 |
| *Moschus Napu*, Napu Musk-deer . . . | B d 179—B d 180 |
| *Megaceros Hibernicus*, Extinct Irish Deer | B d 181—B d 184 |
| *Cervus Tarandus*, Rein Deer . . . . | B d 185—B d 186 |
| *Cervus Dama*, Fallow Deer . . . . . | B d 187—B d 188 |
| *Camelopardalis Giraffa*, Giraffe . . . | B d 189—B d 190 |
| *Antilope Euchore*, Antelope . . . . . | B d 191—B d 192 |
| *Antilope picta*, Nylghau . . . . . | B d 193—B d 196 |
| *Capra Hircus*, Goat . . . . . | B d 197—B d 198 |
| *Ovis Aries*, Sheep . . . . . | B d 199—B d 202 |
| *Bos Taurus*, Ox . . . . . | B d 203—B d 206 |
| *Bos*, Sacred Ox of the Egyptians . . . | B d 207—B d 208 |
| *Bos* ? . . . . . | B d 209 |

Order CARNIVORA.

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| *Trichecus Rosmarus*, Walrus . . . . | B d 210—B d 211 |
| *Phoca vitulina*, Seal . . . . . | B d 212—B d 213 |
| *Cystophora proboscidea*, Seal . . . . | B d 214—B d 215 |
| *Ursus maritimus*, Polar Bear . . . . | B d 216—B d 217 |
| *Ursus Americanus*, Bear . . . . . | B d 218—B d 219 |
| *Procyon lotor*, Raccoon . . . . . | B d 220—B d 221 |

| | No. of Preparations. |
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| *Meles taxus*, Badger . . . . . | B d 222—B d 225 |
| *Putorius Furo*, Polecat . . . . . | B d 226—B d 228 |
| *Putorius Furo*, var., Ferret . . . . . | B d 229—B d 230 |
| *Lutra vulgaris*, Otter . . . . . | B d 231—B d 233 |
| *Mangusta Ichneumon*, Ichneumon . . . | B d 234—B d 235 |
| *Mangusta Mongos*, Mongoose . . . . | B d 236—B d 237 |
| *Canis Vulpes*, Fox . . . . . | B d 238—B d 239 |
| *Canis Lupus*, Wolf . . . . . | B d 240—B d 241 |
| *Canis familiaris*, Dog . . . . . | B d 242—B d 245 |
| *Hyæna crocuta*, Hyæna . . . . . | B d 246—B d 247 |
| *Felis Leo*, Lion . . . . . | B d 248—B d 252 |
| *Felis Tigris*, Tiger . . . . . | B d 253—B d 255 |
| *Felis Onca*, Jaguar . . . . . | B d 256—B d 257 |
| *Felis concolor*, Puma . . . . . | B d 258—B d 259 |
| *Felis Catus*, Cat . . . . . | B d 260—B d 263 |

Order QUADRUMANA.

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| *Galeopithecus philippinensis*, Flying Lemur | B d 264—B d 265 |
| *Lemur tardigradus*, Lemur . . . . . | B d 266—B d 267 |
| *Ateles paniscus*, Spider Monkey . . . | B d 268—B d 269 |
| *Macacus Rhesus*, Short-tailed Monkey . | B d 270—B d 271 |
| *Semnopithecus Entellus*, Entellus Monkey . | B d 272—B d 273 |
| *Pithecus Satyrus*, Orang-utan . . . . | B d 274—B d 277 |
| *Troglodytes niger*, Chimpanzee . . . . | B d 278—B d 281 |

Order BIMANA.

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| *Homo sapiens*, Man . . . . . | B d 282—B d 350 |

# INTRODUCTION.

THE hard tissues composing the skeleton of Plants and Invertebrate Animals having been described in the preceding volume, those forming the skeleton of Vertebrate Animals follow next in order, and are the subject of the present one.

The skeleton is now usually divided into three kinds, viz. an Endo-skeleton, Exo-skeleton, and a Splanchno- or Visceral-skeleton. In the majority of animals it is internal to the soft parts, and therefore named an *Endo-skeleton*; in many fishes, and in the Armadillos amongst the Mammalia, the hardest part is tegumentary and external to the soft parts, hence it is termed an *Exo-skeleton*; but there are some few examples in which certain viscera and organs of sense, such as the heart of the Hog and of most old Ruminants, and the eyes of fishes and birds, have bone as a means of support; such specimens of hard tissue are considered as belonging to the *Splanchno* or *Visceral* skeleton.

The principal structures entering into the formation of the vertebrate skeleton, such as cartilage, fibro-cartilage, fibrous and adipose tissues, have already been described in the first volume of this Catalogue; but another element, consisting of an intimate union of animal and earthy material, known as *bone*, remains to be treated of, and this must be done somewhat in detail, in order that many of the terms occurring throughout the present volume may be fully understood.

Every bone may be said to be composed of a hard and of a soft part; the first consisting of certain salts of lime, magnesia, and soda, the second of the animal substances termed gelatin and chondrin, forming the matrix in which the salts are imbedded; to these may be added in the fresh state, the periosteum investing the outer surface of the bone, and the medullary membrane lining the interior, together with blood-vessels and a certain amount of adipose tissue and oil.

In order the better to understand the several parts entering into the composition of a well-macerated bone, a vertical section of a long one may be selected, —such for instance as the femur of a human subject,—and it will be found to consist of a central portion or *shaft* and two articular extremities; the shaft is hollow, and contains the marrow or medulla,—the cavity therefore has been

termed *medullary cavity*: sometimes the cavity, as well as the two ends of the bone, are occupied by a spongy kind of bony tissue; this has received the name of cancellated or cancellous structure, the openings or spaces being termed *cancelli*. When the outer surface of the bone is examined, many minute holes or foramina for the passage of blood-vessels may be observed; one of these is generally larger than the rest; through it the medullary artery passes into the interior. If a transverse section of such a bone be made sufficiently thin to be transparent, and then examined with a power of 12 diameters, a portion of it will present such an appearance as that shown in Plate XVI. fig. 1; a series of holes of various sizes, *c c c*, will be observed, around which are concentric rows of dark spots; the holes are known as *Haversian canals*, from Clopton Havers, their first discoverer, and the black spots are called *lacunæ* or *bone-cells*. The canals are larger on the inner margin of the bone *b*, than on the outer, *a*. If the section be now examined under a power of 95 diameters, a portion of it will present the appearance shown in fig. 2, the canals being surrounded by a series of concentric lines, known as *laminæ*, between which are the lacunæ before mentioned, but which have now assumed a very different appearance: from the central dark portion numerous filaments radiate; these are tubular, and are termed *canaliculi*: the canaliculi nearest the Haversian canal open into it, and the minute dots seen when the canals are examined with a high power, as shown at *a* in fig. 6, are the orifices of the canaliculi. The canaliculi from the opposite side of the same lacunæ, anastomose with those of the lacunæ of the next lamina; but those of the outer row of lacunæ bend back and join those of the preceding lamina: by this arrangement a transparent line, like that shown in Plate XVII. fig. 1, is produced. Each canal, with its accompanying concentric arrangement of laminæ and lacunæ, has been termed an *Haversian system*, and the transparent line forms a well-marked boundary: in many cases the Haversian systems nearly touch each other in all parts of their circumference, but, as a general rule, certain triangular portions of bone, such as that shown at *a* in fig. 2, without any canal in the centre, fit in between them; to such, the name of *Haversian interspaces* has been given: in these, very frequently, there are no laminæ, and the lacunæ are of a different shape to those in other parts of the specimen. If a section be now made of the same bone in a vertical direction, and examined with a power of 12 diameters,

the course of the Haversian canals will be seen, as shown in Plate XVI. fig. 3: they run for the most part in parallel lines, frequently bifurcating or giving off transverse communicating branches. The laminæ, instead of being arranged in concentric circles, as in the transverse section, will now be seen to be disposed in lines parallel with the walls of the canals, as may be observed at *a* in fig. 4; but should a canal be divided obliquely or transversely, the laminæ will be either oval or concentric, as shown at *b*. All the parts previously spoken of may be seen with a power of 100 diameters; but if a higher one be used, the tissue between the lacunæ will be found more or less granular, as shown in fig. 5: these are the particles of osseous matter which give strength to the bone, and are termed *osseous granules.*

The principal structures entering into the formation of a long bone may therefore be thus enumerated: viz. the shaft, the articular extremities, the medullary cavity, the cancelli, the Haversian canals, the Haversian systems, the Haversian interspaces, the lacunæ, the canaliculi, the laminæ, and the osseous granules. Some of these will now be spoken of more in detail.

*Haversian canals.*—The Haversian canals vary considerably in size in different parts of the same bone: on the inner or medullary margin, where they contribute to the formation of the cancellated structure, they are large, as shown at *b b* in Plate XVI. fig. 1, but towards the periphery, *c c*, they are much smaller; and, as is well shown in figs. 3 & 12, they frequently anastomose. The office of the Haversian canals is to carry vessels, and these are occasionally to be seen full of blood in sections which have been dried, as may be exemplified by consulting Preparations B d 12 & 13; but the blood-vessels are still better seen in sections of bones that have been injected artificially, as shown in Plate XVI. figs. 12 & 13. The walls of the Haversian canals, when divided transversely, have generally a smooth and regular outline, as shown in the various figures; but there are other openings, only lately discovered by Messrs. Tomes and De Morgan*, in which the outline is jagged or festooned, as shown at *a*, in Plate XV. fig. 17, and have been termed by them *Haversian spaces*; they are produced by absorption, and in process of time are again filled up with new laminated bone: the boundary line of an Haversian space may be at once distinguished from that of an Haver-

* "Observations on the Structure and Development of Bone." Philosophical Transactions, 1852.

sian system by its festooned outline, which to all appearance has been produced by the partial absorption of the boundaries of several Haversian systems.

*Laminæ.*—When a transverse section of bone is examined with a power of 95 diameters, as shown in Plate XV. fig. 15, each Haversian system is found to be surrounded with a series of concentric laminæ: on the outer and inner margin of the same section other laminæ will be seen; these, from completely surrounding the periphery, are termed *circumferential*; those on the outer margin are shown at *a*, in Plate XVI. fig. 1. Other laminæ occur between the several Haversian systems, as for instance those shown at *a* in Plate XV. fig. 15, which have been named *interstitial*; these, as a general rule, are not so distinctly marked as either of the other kinds. According to Messrs. Tomes and De Morgan, each lamina, when fully developed, is made up of two parts; an outer, which is highly granular, composed of a single line of large granules or cells, as shown in Plate XV. fig. 18, and an inner portion, without any traces of granulation or any recognizable structure. Many transverse sections in which the lamination is very strongly marked, are described in the Catalogue; one or two in particular may be noticed, viz. that of the *Phalangista*, B d 21, and a Human bone impregnated with earthy material in a crystalline form, B d 349, and represented in Plate XVIII. fig. 9. The laminæ are also well seen in bones which are in an hypertrophied condition, as for instance in the specimen represented in Plate XV. fig. 14, and in a case of atrophied femur, represented in fig. 15. The bones of the smaller Mammalia, as the Mouse and Bat, not unfrequently exhibit only one kind of lamina, the circumferential, as shown in Plate XII. fig. 1; this is very common among Reptiles, as may be seen in Plate VIII. figs. 5, 9 & 13, the medullary cavity performing the office of an Haversian canal.

*Lacunæ.*—The peculiar spider-like bodies occurring between the laminæ, are known as bone-cells or lacunæ; they exist in all true bone, and consist of a central portion or body, and radiating tubuli, or *canaliculi*. Within the body of the cell, a nucleus is often present, with smaller, highly refracting particles resembling globules of oil. As a general rule lacunæ are of a flattened oval figure, and their long diameter is disposed in a line with the Haversian canals; in transverse sections of bone therefore, when arranged in concentric circles, they are mostly divided in the direction of their short diameter. The canaliculi nearest to the Haversian canals, as before stated, open into the canal, whilst

those more distant anastomose with the canaliculi of neighbouring lacunæ; by this arrangement, the liquid portion of the blood, supposed to exude through the walls of the vessels during life, is taken up by the first row of canaliculi, and by them conveyed to all the lacunæ forming an Haversian system. The lacunæ vary in size in different animals, and are even seen to be of three different shapes in the same section; they will be found described as the elongated, the oval, and the circular, in most of the longitudinal sections of Mammalian bone; the difference in size not unfrequently being due to the direction in which the section has been made. The largest lacunæ described in the present volume are those from a fossil fish, Preparation B a 225; one of these, for the sake of comparison, is represented in Plate V. fig. 12; it measures $\frac{1}{160}$th of an inch in its long diameter: the next in size are found in the bones of the *Lepidosiren*, Plate V. figs. 21 & 23, and in those of the Perennibranchiate Reptilia, Plate VIII.; in Birds they are very much smaller, as may be seen in Plate X. In the recent Mammalia, the longest occur in the Three-toed Sloth, as represented in Plate XVIII. fig. 4; but amongst the fossil, those of the Mylodon, shown in fig. 5, are still longer. A remarkable relation in point of size has been found to exist between the blood-corpuscles and the lacunæ of the same animal; thus, for instance, in the Siren and Lepidosiren, animals having the largest blood-corpuscles, the lacunæ are also the largest; in the Sloths the blood-corpuscles are larger than in any mammal except the Elephant; in one of these, the Three-toed species, the lacunæ are the largest. There are, however, some few instances in which this rule has been departed from, and these are alluded to in different parts of the present volume. The development of the lacunæ has for a considerable time been the subject of investigation; it is, however, now established that they are the altered nuclei of certain cells, termed lacunal cells by Tomes and De Morgan. In Plate XVIII. fig. 10 is shown the mode in which the development takes place; *a* represents a lacunal cell, *b* the nucleus which is termed the granular cell, *d* the nucleolus: in process of formation, the granular cell *b* assumes a stellate appearance like that of a lacuna, as shown at *d*, the original cell-wall *a* disappears, and the altered granular cell *e* is left as a lacuna; subsequently the matrix in which the lacunæ are imbedded becomes hardened by a deposit of the earthy salts, and so the bone is completed. All these stages may be seen in sections of ossifying cartilage, and especially in portions of certain enchondromatous tumours.

*Bone Tissue.*—All the principal structures entering into the formation of bone, with the exception of the bone-tissue, having now been described, this follows next in order. When a section of bone is examined under a very high power, as shown in Plate XVI. fig. 5, the spaces between the lacunæ and their canaliculi are occupied with bone-tissue, that is, by granules of osseous matter, imbedded in a more or less homogeneous matrix. The osseous granules vary considerably in size in different specimens of bone: in the thin cranium of small birds, and in that of the Bat, as shown in Plate XVI. fig. 7, they are of angular figure; they are also well exhibited in sections of ossifying cartilage, as represented in fig. 8; in various specimens described in other parts of this work, such as the bones of the Cetacea, and the section of frontal bone of the Human subject, shown in Plate XV. fig. 8, they are also well seen. Bones that have been long boiled or burnt in contact with air, and those which have been treated with caustic potash, are well calculated to exhibit the granules, as was first pointed out by Mr. Tomes, who found that they varied in size from $\frac{1}{6000}$th to $\frac{1}{14000}$th of an inch.

When the granules have been dissolved out of the matrix by long steeping in dilute hydrochloric acid, very minute cavities will be seen, in which the granules were lodged; this is well exemplified in Preparation B d 140, represented in Plate XVIII. fig. 11. The granular structure is not evident in all sections of bone; sometimes an Haversian canal will be found surrounded with a ring of perfectly structureless bone; this is very common in the antlers of the Deer, as shown in Plate XVIII. figs. 13, 14. If a growing bone be carefully examined after the removal of the periosteum, it will be noticed that the free surface is invested with a soft tissue made up of small oval cells, which by Messrs. Tomes and De Morgan have been termed *osteal cells*; they are shown at *a* in Plate XVIII. fig. 12. They resemble the granular cells of temporary cartilage, and like them may ultimately become lacunæ, but as a general rule they either form a compact mass or assume a linear arrangement as shown at *c*, and becoming ossified give rise to the laminated condition of bone before noticed;—lamination, according to the authors above quoted, "being nothing more than a definite linear arrangement of the osteal cells with their outlines permanently retained in the perfected bone."

# HISTOLOGICAL CATALOGUE.

## PHYSIOLOGICAL SERIES.

### Division II.

### HISTOLOGY OF ANIMALS.

#### Series VII.

*Sclerous or Hard Tissue.*

Subseries I. *Constituents of the Skeleton of Vertebrate Animals.*

As before stated in the Introduction, page xix, every bone is composed of a hard and of a soft part; the first consisting of the earthy salts, the second of the animal matrix in which they are imbedded. The earthy salts, according to modern chemical analysis, amount to about two-thirds of the weight of an adult bone; they are made up principally of phosphate and carbonate of lime, phosphate of magnesia, and small proportions of fluoride of calcium and chloride of sodium. The animal or soft constituent, when freed from all traces of the earthy one, by long maceration in dilute hydrochloric acid, consists of a tough flexible material, retaining to a certain extent the exact shape of the original specimen of bone, and composed principally of gelatin, and chondrin. In the fresh state, the periosteum, the medullary membrane, the blood-vessels, and a certain amount of adipose tissue and oil are also present; some of these have already been described in the first volume of this Catalogue. The above description applies only to such bones as strictly enter into the composition of the vertebrate skeleton, and such as on section will be found to exhibit both laminæ and lacunæ; all such bones are called true bone in contradistinction to others occurring in abnormal situations, such as in the coats of arteries, in tumours and in other morbid products, which are simple ossifications of fibrous or other tissues, and from containing no lacunæ are termed spurious or false bones.

a. *Earthy constituent of Bone.*

B 1. A transverse section of a femur of an adult *Human subject*, which has been deprived of its animal matter by maceration in Liquor Potassæ. The preparation still retains its original shape, and its laminated structure is preserved ; but all traces of lacunæ and canaliculi have disappeared. The entire section is minutely granular. A portion of this section is represented, under a power of 130 diameters, in Plate XVIII. fig. 15.

B 2. A portion of the shaft of the femur of an adult *Human subject*, which has been subjected to the action of heat for many hours, with full exposure to the air. By the slightest pressure it was reduced to powder, and, when examined with a power of 500 diameters, is found to consist of a series of angular particles, varying in size from the $\frac{1}{2000}$th to $\frac{1}{15000}$th of an inch ; these are the so-called osseous granules.

B 3. A portion of the cranium of a small Bat, *Vespertilio noctula*, exhibiting osseous granules of large size and angular figure, as shown in Plate XVI. fig. 7.

B 4. A vertical section of the ossifying epiphysis of the lower extremity of the femur of a fœtal *Wolf*, exhibiting osseous granules deposited in large quantities in the matrix surrounding the cartilage-cells. A portion of this specimen is represented in Plate XVI. fig. 8.

B 5. A vertical section of a tumour of the Uterus, which is made up principally of a mass of fibres having numerous minute osseous granules deposited around them, but no trace of lacunæ. A portion of this specimen is represented in Plate XVI. fig. 9, and it will be seen that on one side there are rounded bodies like globules of fat.

B 6. A thin plate of osseous matter removed from the interior of a diseased aorta ; it is made up of fibres and of circular bodies, like globules of fat, around both of which, osseous granules are deposited in large quantities, but there is no trace of lacunæ.

b. *Animal constituent of Bone.*

B 7. A transverse section of the femur of an adult *Human subject*, being part of the same section as that from which Preparation B d 1 was taken. It has been macerated in dilute hydrochloric acid. The laminated structure and the lacunæ are both well displayed. A portion of this section, magnified 130 diameters, is represented in Plate XVIII. fig. 16.

B 8. A transverse section of the shaft of a femur of an adult *Human subject*, which has been macerated for some hours in muriatic acid to take away the earthy matter. The Haversian canals, the laminæ, and the lacunæ are visible, but not the canaliculi, although there is an evident appearance of a radiated structure crossing the laminæ.

B 9. A transverse section of the same femur, one-half of which has been treated with acid, and the other half left in its natural condition. There is very little difference in structure between the two; both exhibit canals and lacunæ, and traces of canaliculi; the decalcified portion is more transparent than the other, and exhibits the radiating structure described in the preceding specimen, and like all portions of bone deprived of their earthy matter, it is much thicker than the untouched part, as may be readily seen by examining the line of demarcation between the two. When one part is in, the other will be always out of, focus.

### c. *Laminæ of Bone.*

B 10. A transverse section of the tibia of an adult *Human subject*. It is in an hypertrophied condition, and with one or two exceptions exhibits the laminated structure more plainly than any preparation hereafter described. When viewed with the naked eye, numerous large openings are visible, but when viewed microscopically, they differ from Haversian canals, and have been described by Messrs. Tomes and De Morgan as Haversian spaces. A portion of this specimen, showing the laminated structure, is represented in Plate XV. fig. 14, and another exhibiting an Haversian space in fig. 17. The space is shown at *a*, its margin is festooned, and is formed by the walls of several Haversian systems; it will be at once seen that it differs considerably from an Haversian canal.

*Presented by Campbell De Morgan, Esq.*

B 11. A transverse section of the femur of a *Man* 35 years of age, who from the age of 3 years had suffered from atrophy of his right lower extremity, and all the muscular substance was replaced by adipose tissue. It exhibits most plainly the laminated condition of the bone; one portion is represented in Plate XV. fig. 15, and another portion, under a power of 440 diameters, in fig. 18. In this latter figure it will be seen

that the opaque portion of each lamina is made up of a linear arrangement of the so-called *osteal cells* of Tomes and De Morgan. When more highly magnified, they present the appearance shown at *c* in Plate XVIII. fig. 12.

*d. Periosteum of Bone.*

B 12. A portion of periosteum, removed from the tibia of a young *Pig*; it is a strong silvery membrane, composed principally of white fibres arranged in a parallel direction, sometimes crossed by others at right angles. Another specimen of periosteum is described in Vol. I. of this Catalogue; it forms Preparation A b 3.

B 13. A portion of periosteum removed from the anterior surface of the tibia of a *Human fœtus*; the blood-vessels are injected, some of them are arranged like those of areolar tissue, others are straighter and somewhat resemble those of muscle.

B 14. A portion of periosteum removed from the Os innominatum of a *Human fœtus*. The blood-vessels are injected; they very much resemble those of muscle, as represented in Plate XVI. fig. 11. Other specimens of the vessels of the periosteum are described in Vol. I.; they form preparations A b 8 and A b 9.

*e. Vessels of Bone.*

B 15. A vertical section of the tibia of a *Rabbit*, the blood-vessels of which have been injected. It exhibits two kinds of bone, that shown at *a*, in Plate XVI. fig. 12, being the original shaft, whilst that at *b* is new bone developed after injury to the periosteum; the Haversian canals are occupied by blood-vessels, which are both larger and more numerous in the new bone than in the old.

B 16. A vertical section of the shaft of the femur of a *Calf*; it has been injected, and the blood-vessels, as shown in Plate XVI. fig. 13, will be noticed running in canals in the centre of the shaft; they are very small in proportion to the size of the canals, all the surrounding spaces having been filled with soft fat. Other specimens of the vessels of bone are described in Vol. I., under the heads A k 3, A k 4, and A k 5.

# Division II.

## ENDO-SKELETON OF FISHES.

### Subseries XIII. *Endo-skeleton of Fishes.*

In the following series of Preparations, the usual mode of classification into orders will not be adhered to, but the arrangement adopted will be founded,—1st, on the situation of the skeleton whether endo-, exo- or splanchno-; and, 2nd, on the nature of the tissue of which such skeleton may be composed; the ordinary division of Fishes into two groups, viz. the Cartilaginous and Osseous, will however be retained with some slight modifications.

a. *Fishes in which the Endo-skeleton is composed of fibrous tissue and a hyaline substance resembling cartilage.*

B a 1. Transverse sections of the body of a Lancelet, *Amphioxus lanceolatus*; in the centre may be seen the chorda dorsalis, which is known by its brown colour, and also by its being surrounded with a firm fibrous sheath; this is continued towards the dorsal surface and encloses the nervous axis, and is intimately blended with a white band, termed the superior ligament by Prof. Goodsir; it then passes upwards and becomes continuous with the dorsal ridge; prolongations from it pass between the different muscles and seem to form sheaths for them. On the abdominal surface the sheath appears to divide, and after lining the abdominal cavity, becomes continuous with the common integument. In the mesial line immediately beneath the chorda dorsalis and attached to the sheath, is seen the inferior ligament, having on either side of it the splanchno-ribs, which arch downwards and outwards, and are attached to a sternum in the mesial line.

B a 2. A portion of the chorda dorsalis of a *Lancelet*, which, with a magnifying power of 40 diameters, exhibits a fibrous structure, the fibres being arranged in a circular form; on its upper and under surface may be seen a white line, indicating the superior and inferior ligament.

B a 3. A portion of the chorda dorsalis of a *Lancelet*, which has been detached from its muscular investments; when examined under a power of 250 diameters it shows that the outer portion of the sheath is composed of a series of circular fibres of a more or less yellow colour, and so firmly adherent as to be with difficulty unravelled; in some parts the whole substance of the chorda appears to be made up of fibres, in others it presents a tubular character, and contains within it circular disc-like bodies, which may be considered as rudimentary vertebræ.

B a 4. A series of discs obtained from the chorda dorsalis of a *Lancelet*; they are of a circular form, about the $\frac{1}{50}$th of an inch in diameter, and are made up of fibrous bands arranged in parallel lines, with here and there a trace of minute cells somewhat like those of cartilage: one of these discs is represented of the natural size in Plate I., fig. 1 *a*, and a segment of the same under a power of 130 diameters at *b*.

B a 5. A series of splanchno-ribs (Goodsir) of a *Lancelet*, exhibiting their origin, which seems to be by loops, each formed by two ribs; these are firmly connected with the inferior ligament; they then pass downwards and outwards, forming a series of curves towards the mesial line, near which they bifurcate, each extremity terminating in a sternum not continuous with that of the opposite side; the bifurcating extremities being inclined towards the upper and lower rib of the same side.

B a 6. A similar preparation of the splanchno-ribs of a *Lancelet*, showing the sternum better than the preceding; both sets of ribs are present, a few of them are covered by a fine granular substance, others, in which this appearance is absent, exhibit a series of equal-sized cells, which are attached principally to their internal and external surfaces; in some places between the ribs there are traces of tesselated epithelium.

B a 7. Another series of splanchno-ribs from the same *Lancelet*, deprived of all their investments; they consist of tubular filaments of a hyaline substance somewhat of the nature of cartilage, arranged in parallel lines, and about $\frac{1}{40}$th of an inch apart; from the opposite sides of each alternate rib a small filament is given off, which passes across at an angle of

nearly 45°, and is connected to the adjoining rib by an expansion of membrane. A portion of this Preparation, as seen under a power of 25 diameters, is represented in Plate I. fig. 9; and another portion of it, under a power of 250 diameters, is shown at fig. 10.

The foregoing series of Preparations will serve to show that there is no tissue in the Lancelet that can strictly be called cartilage, although it is generally classed with the cartilaginous fishes. The specimens from which the preparations were taken, were brought from Naples by Prof. Owen in 1847, where they are tolerably abundant, and are employed as shrimps in sauce for larger fish. The Lancelet was found on the east coast of Cornwall as early as the latter part of the last century, and was described by Pallas as a naked Mollusk. Costa in 1834 classed it amongst the fishes.

b. *Endo-skeleton composed of cellular cartilage and fibrous tissue.*

B a 8. A transverse section of the vertebral column of a Myxine, *Myxine glutinosa*, taken from about the middle of the body, where the chorda dorsalis is $\frac{3}{8}$ths of an inch in diameter, and the sheath and other parts composing the column are but sparingly developed. In the centre of the chord may be noticed a stellate mass of a yellow colour, which appears to be composed of condensed cellular tissue, like that of the sheath, and analogous to the straight transverse division of the Sturgeon presently to be described; the chord itself is made up of cellular cartilage, and the cells in the neighbourhood of this stellate mass are smaller than those in other portions of the chord, and in arrangement are precisely similar to those attached to the sheath; the other cells have thin walls, and nearly resemble those of the Sturgeon and Lamprey; the sheath of the chord is very thin, and the parts surrounding the neural axis are composed of delicate laminæ, between which a loose kind of cellular tissue is seen; this cellular tissue, like that of the Lamprey, contains adipose tissue. The cells of the cartilage are on an average $\frac{1}{100}$th of an inch in diameter, and might readily be mistaken for those of vegetables.

B a 9. A transverse section of the chorda dorsalis of the same *Myxine*, taken from a part nearer the head; the yellow mass occupying the centre is less

stellate than that of the preceding specimen, but the arrangement of the cells is similar.

B a 10. A transverse section of the chorda dorsalis of the same *Myxine*, taken from a spot still nearer the head ; the yellow mass is now in the form of a transverse septum, dividing the chord into two symmetrical halves ; the diameter of the chord is about one half that of the preceding specimens, but the sheath is thicker.

B a 11. A transverse section of the chorda dorsalis of the same *Myxine* still nearer the head, in which it may be seen that the chord divides into two branches, both of which are invested by a strong separate sheath ; the neural axis is present, and is surrounded by a ring of fibrous tissue about $\frac{1}{12}$th of an inch in thickness.

B a 12. A transverse section of a firm cartilaginous style, connected with the muscles of the tongue of the same *Myxine*, which has a white centre and a yellow margin ; when examined with a power of 100 diameters, the central portion consists of thick-walled cartilaginous cells like those in the corresponding part of the Lamprey ; as we proceed towards the margins, the cell-walls begin to disappear, and large oval nuclei imbedded in a structureless matrix are seen.

B a 13. A vertical section of the same cartilaginous style of the *Myxine*, exhibiting a white centre and yellow margin ; in the centre the cells somewhat resemble those of the corresponding part in the transverse section ; on proceeding towards the margin, the cell-walls disappear, and nothing but a mass of large oval nuclei are seen ; still nearer the margin, the nuclei become smaller and less numerous, and are so widely separated that the structureless matrix is very evident.

B a 14. A transverse section of the chorda dorsalis of a Lampern, *Petromyzon fluviatilis* ; it consists of an outer fibrous membrane or sheath, within which gelatinous cartilaginous matter is contained, the central portion of the cartilage being softer than that of the circumference ; it consists of a series of cells on an average $\frac{1}{300}$th of an inch in diameter, arranged some-

what in a radiating form, those in the centre, as shown in Vol. I., Plate V., fig. 1 *cc*, exhibiting nuclei: these cells are remarkable for their resemblance to the cellular tissue of vegetables.

B a 15. A longitudinal section of the chorda dorsalis of the same *Lampern*, exhibiting a series of cartilaginous cells arranged in straight lines; they are attached to a portion of the sheath of the chorda, which may be very readily known by its fibrous structure, the fibres being arranged concentrically; the cells are so firmly adherent to each other that they cannot be easily separated.

B a 16. A transverse section of firm cartilage of the same *Lampern*, taken from the base of the tongue; being homologous with that of the Myxine (Preparations B a 12, 13); it is of an oval figure, and the central part consists of a series of thick-walled cells of nearly uniform size; as we proceed towards the circumference, the cells become smaller, and their walls much thicker, till finally, almost the entire cavity is filled up, and the cell-walls have assumed a brown colour.

B a 17. A transverse section of one of the vertebræ of a Lamprey, *Petromyzon marinus*, represented of the natural size in Plate I. fig. 27; at *a* is seen the chorda dorsalis with its sheath, at *b* the neural, and at *c* the hæmal canal.

B a 18. A transverse section of the chorda dorsalis of the same Lamprey, shown of its natural size in Plate I. fig. 11 *a*; its structure is similar to that of the Lampern, Preparation B a 14: a segment of it, magnified 50 times, is represented by fig. 11 *b*, and a few of the cells, as seen under a power of 130 diameters, are shown in fig. 12: some of them exhibit nuclei.

B a 19. A transverse section of a portion of the tissue surrounding the spinal chord and chorda dorsalis of the *Lamprey*, being that part which in the Sturgeons, Sharks and other highly organized fishes, is made up of firm cartilage; it consists of a framework of fibres enclosing a number of adipose cells; in the Lampern the same thing is also to be seen. A portion of this preparation is represented in Plate I. fig. 31, as seen under a power of 130 diameters.

B a 20. A similar preparation which has been macerated in ether, whereby the fatty matter is removed; the fibrous framework and the cells which contained the fat are now plainly seen: a portion of this specimen is also represented in Plate I. fig. 32.

B a 21. A transverse section of cartilage connected with the muscles of the tongue of a *Lamprey*; it is of an oval figure, and consists of an outer margin of a brown colour composed of thick-walled cells, some of which exhibit scarcely any trace of a cavity; the central portion is made up of larger cells with thinner walls, and of an hexagonal figure; the section is of a similar character to that of the Lampern, Prep. B a 16. This specimen, magnified 12 diameters, is represented in Plate I. fig. 36, and a portion of the same, including the margin, in Plate I. fig. 37.

B a 22. A portion of the vertebral column of a *Trout* five days old; it consists of a fibrous sheath enclosing a soft chorda dorsalis, which, like that of the Lamprey, is composed of large thin-walled cells; on the upper surface of the sheath may be seen a row of neural spines, which are composed of cartilage entirely made up of nucleated cells; each spine is expanded at its root and firmly imbedded in the sheath; in some cases, as shown in Plate I. fig. 33, the cartilage of the base of one spine is continuous with that of the neighbouring spine; this latter form of cartilage in process of time becomes ossified, whereas that of the chorda dorsalis entirely disappears.

B a 23. A portion of the spinal chord of a *Trout* about two months old, in which the chord is now being marked out by vertical lines at regular distances; these indicate the situations of the future vertebræ; when viewed with a power of 130 diameters, the fibrous sheath and the cells of the chorda may be plainly seen: on the outer side of the sheath are four bands of cartilage, one superior, to which the neural spines are attached, the other inferior, for hæmal spines, and two lateral for the pleurapophyses; immediately opposite the base of each neural spine may be seen a portion of fibrous tissue resembling an inflection of the sheath of the chord, which passes downwards in a nearly straight line, and so marks out the articulating surface of a vertebra; this fibrous structure is within the sheath of the chord, for the large cells can be distinctly traced over it; on the upper

and lower edge of the sheath may be noticed a concave spot to which the spines are attached: it is precisely opposite to these that the fibrous septa already alluded to are given off.

c. *Vertebral column composed of cartilage and fibro-cartilage.*

B a 24. A transverse section of the body of a Callorhynchus, *Chimæra callorhynchus*, including the dorsal and anal fin; it shows the small amount of cartilage surrounding the sheath of the chord. This preparation is represented in Plate I. fig. 23; at *a* is seen the sheath, at *b* the chorda dorsalis, and at *c* the cartilage surrounding the nervous chord and blood-vessels.

B a 25. A transverse section of the sheath surrounding the chorda dorsalis of the same *Callorhynchus*; it is $\frac{1}{4}$ of an inch in diameter, and of a silvery whiteness, being composed of radiating and circular fibres, amongst which may be seen very many minute cartilaginous cells; the small opening in the centre was occupied by the chorda dorsalis, which, like that of the Lamprey, is made up of large thin-walled cells. A portion of the sheath, as seen under a power of 130 diameters, is represented in Plate I. fig. 24; the cells are of circular figure, each containing one or more nuclei; they are firmly imbedded in the fibrous matrix.

B a 26. A transverse section of the sheath inclosing the chorda dorsalis of the same *Callorhynchus*, which has been mounted in glycerine, whereby the silvery appearance is lost, but the striæ and the cartilaginous cells are still plainly visible; the chorda dorsalis at this part is $\frac{1}{12}$th of an inch in diameter.

B a 27. A transverse section of the sheath of the chorda dorsalis of the same *Callorhynchus*, with a portion of cartilage attached; this last consists of minute nucleated cells imbedded in a structureless matrix; the cartilage is separated from the fibrous tissue by a well-defined line, but the cells in the sheath and in the cartilage are identical in structure; a portion of the cartilage is represented in Plate I. fig. 25.

d. *Vertebral column composed of cartilage, fibro-cartilage, and bone.*

B a 28. A transverse section of the vertebral column of a small Sturgeon, *Aci-*

*penser Sturio*; it shows that the sheath surrounding the chorda dorsalis is much thinner than that of the Callorhynchus, whilst the chord itself is very large; the cartilage surrounding the sheath is not in one piece, but made up of four segments; the curved aperture *a*, Plate I. fig. 28, is that through which the blood-vessels passed, the circular one, *b*, above it enclosed the nervous chord.

B a 29. A portion of the cartilage composing the vertebra of the same *Sturgeon*: when viewed with a power of 130 diameters, it is found to be composed of a series of nucleated cartilaginous cells imbedded in a structureless matrix; the cells, as represented in Plate I. fig. 34, being of much larger size than those of the Callorhynchus, and many of them possessing double nuclei.

B a 30. Four transverse sections of a neural spine of a *Sturgeon*, having a central part composed of cartilage, and a margin of bone; the cells of the cartilage are arranged in circular groups, and their nuclei are granular, as though ossification were about to commence in them; in the bony rim, bone-cells may be observed; these are of the kind peculiar to fishes, and are analogous to those in the scales of the skin of the same fish.

B a 31. A transverse section of the vertebral column of the same *Sturgeon*, including the chorda dorsalis and its sheath; the former appears to be made up of two symmetrical halves, being divided transversely by a yellow horny band; it is composed of thin-walled cells like those of the Lamprey, but instead of being arranged in a radiating manner, they proceed in straight lines from above downwards, and are firmly attached to the transverse horny band already mentioned; the cells are largest close to the band, and smallest on the margins, where they adhere very firmly to the sheath; the sheath itself is composed of radiating and circular fibres; on the edges of a greater portion of the cartilage there is a thin layer of bone.

B a 32. Transverse sections of a vertebra of a young Thornback, *Raia clavata*, made at right angles to the length of the spinal column; in the centre may be noticed a circular transparent spot containing minute cartilage cells, arranged in a radiated manner, those in some of the radii becoming

bony by a deposit of earthy matter in the intercellular tissue. The central transparent spot is surrounded by a ring of bony matter, like that represented in figs. 6 and 7 in Plate I.; the other part of the vertebra is made up of ordinary cartilage, and both it and the neural and hæmal canals are covered with a layer of bone in the form of hexagonal plates, like those of the Skate and Shark.

B a 33. Vertical sections of the vertebral column of the same *Thornback*, including portions of three vertebræ: in some parts, the section has passed through the transparent centrum where the cartilage cells are well displayed; in others, the ossifying ring has been divided, and all these parts of the vertebra appear to be composed of bony matter. Each vertebra is surrounded by a casing of hexagonal cells filled with granular osseous matter, like that of the young Dogfish, represented in Plate I. fig. 20.

B a 34. A section of the neurapophysis of a vertebra of a *Thornback*, made at right angles to the length of the fish: when viewed with a power of 250 diameters, the greater part exhibits cartilage cells clustered together; towards the edges of the specimen, the cells are becoming arranged in a linear series; the edge is coated with bone, which at regular intervals encroaches upon the cartilage; the cells of the latter at these points are disposed in a radiating form, and are most numerous where ossification is going on: to the unassisted eye the bony margins have a wavy appearance. A portion of this specimen is shown in Plate II. fig. 30.

B a 35. A similar section to the last described preparation, from which the earthy matter has been removed by acid: the cartilage cells are arranged in the same manner, being disposed in radii where ossification is going on, and all those parts which contained osseous matter are known by the density and closeness of the cells, each of which, as shown in Plate II. fig. 31., contains a well-defined nucleus: the earthy matter was situated in the intercellular tissue.

B a 36. A section made through the body of a vertebra of a *Thornback* in the same direction as that of the preceding specimens, viz. at right angles to the length of the fish: it consists principally of cartilage, having a mass

of bony matter in the centre, somewhat in shape like a Maltese cross; when this is examined with a power of 250 diameters, it is found to be composed of a dense aggregation of minute nucleated cartilage cells, having ossific matter deposited in their walls and in the intercellular substance: in the neighbourhood of the ossific matter the cartilage cells are arranged in a radiated form; but in the other parts they are grouped together in masses of six or eight, as in the specimen of neurapophysis before described.

B a 37. A section of the body of a vertebra of the same *Thornback*, made at right angles to the length of the fish: it is in the form of a ring, the section including that part of the body only which formed the articular surface: it is composed entirely of broad fibres having ossific matter deposited in the spaces between them.

B a 38. A transverse section of the vertebral column of a young *Shark*; the centre is occupied by a dark spot, around which the cartilage is very transparent, and the cells arranged in a circular manner; external to this is an opaque ring from which four short arms radiate: all these are composed of oval cells surrounded by earthy matter. This preparation is represented in Plate I. fig. 6, and a portion of the cartilage magnified 130 diameters is shown at *a*.

B a 39. Two vertical sections of the vertebral column of the same *Shark*: each vertebra, when magnified with a power of 12 diameters, shows that it is composed of two concave articular surfaces which are connected by four osseous vertical bands, whilst the remaining tissue is cartilaginous: one of the vertebræ of this Preparation is shown in Plate I. fig. 22.

B a 40. A vertical section of a portion of the vertebral column of a young Torpedo, *Torpedo vulgaris*: the body of each vertebra is composed of the ossified walls of cartilage cells arranged in lines at right angles to the direction of the vertebral column, which is just the reverse of that of B a 39. In the Dogfish, the shape of the osseous matter, which is in one piece, is precisely that of the section of a perfectly formed vertebra, with its articular surfaces concave: the spaces between the vertebræ are occupied by

hexagonal cells of cartilage, resembling those of the chorda dorsalis of the Lamprey; but in the outer edges of the section, where the osseous matter is most abundant, the cartilage cells are of the same size and shape as those of the vertebra of the Dogfish and Shark. One of the vertebræ is thin and transparent, and shows very plainly the disposition of the cells in the central portion of the body.

B a 41. A transverse section of the vertebral column of a young Dogfish, *Spinax acanthias*: it is of a quadrate figure; the centre is occupied by an opaque mass, probably of the same nature as that described in the centre of the chorda dorsalis in the Sturgeon and Myxine; this is surrounded by a transparent cartilage containing cells, on the circumference of which is a ring of bony matter; from this ring there are no radii as in the Shark, but from each side of the vertebræ are given off two short arms, each of which is composed of osseous matter like that of the ring; it would appear that this vertebra is more advanced in its development than that of the Shark, and shows very clearly the mode in which the cartilaginous substance becomes ossified; this appears to be by the deposition of granules around each cartilage cell: in some of the arms the ossification has taken place in the direction of the fibrous tissue, the fibres being arranged in the form of radii: this is represented in Plate I. fig. 7.

B a 42. A vertical section of a portion of the vertebral column of a young *Dogfish*, including four vertebræ: when these are examined by the naked eye, they are found to consist of two distinct kinds of structure; one opaque, which marks out the framework of each vertebra, the other transparent, and occupying all the space between the opaque parts: when examined with a power of 250 diameters, the former (opaque) part is made up of the partly ossified cell-walls of cartilage; whilst the latter or transparent part is composed of ordinary cartilage, containing minute oval nucleated cells: the connecting tissue of the vertebra is present, and more or less of it is seen between the concave articular surfaces; it is in the form of a membrane, in which are a few cartilage cells arranged in parallel rows. On one side of the vertebræ a portion of the sheath is left; this has a fibrous structure.

B a 43. A similar preparation to the last, in which the section has been made through the centres of the vertebræ, and shows that the greater portion of each is composed of ossific matter, the cartilage being only present in a small triangular spot on each side of the mesial line.

B a 44. A horizontal section of the body of a vertebra of a Basking Shark, *Selache maxima* ; it consists of a series of bony segments, which exhibit externally a radiated, and internally a concentric laminated structure: half of this section, one-third the natural size, is represented in Plate II. fig. 19.

B a 45. A vertical section of one of the same vertebræ taken through the centre of the body; it shows the concave articular rings and the bony radii which connect them ; this preparation, also one-third the natural size, is represented in Plate II. fig. 20: all the dark spaces of both these sections in the recent fish were occupied by cartilage.

B a 46. A horizontal section of a portion of the body of a vertebra of the same Basking Shark ; in the centre may be seen one of the vertical columns of bony matter having cartilage on both sides ; when viewed with a power of 250 diameters, the cartilage is found to be made up of nucleated cells imbedded in a fibrous matrix, the fibres being arranged in bundles ; in the centre of the specimen is seen a section of one of the columns ; this is composed of rings of bony matter produced by the ossification of the matrix around the cartilage cells, and within the ring the nucleus of the cell is still visible ; a portion of this preparation, in which the bundles are well displayed, is represented in Plate II. fig. 22.

B a 47. A similar preparation which has been mounted in a mixture of gelatine and glycerine, whereby all the parts composed of cartilage and fibrous tissue are rendered very transparent, and the bony matter brought more plainly into view: if the thin edge of the section be examined, the rings of osseous matter may be well seen, but their outline, as shown in Plate I. fig. 16, is very irregular.

B a 48. A transverse section of a portion of the body of the same vertebra, ex-

hibiting two columns surrounded by cartilage: the cartilage consists of rows of nucleated cells separated by parallel fibres; the bone is plainly shown to be produced by the ossification of the matrix around the cartilage cells, and not by the fibrous tissue. One portion of this preparation is represented in Plate II. fig. 23; and another, in which the nuclei are well seen, in Plate I. fig. 15.

B a 49. A tangental section of the ring or articulating surface of the same vertebra; it is composed of a series of parallel fibres of nearly uniform diameter, each of which is covered with granules of osseous matter. A portion of this preparation, as seen under a power of 200 diameters, is represented in Plate I. fig. 17.

B a 50. A similar preparation which has been mounted in a mixture of glycerine and gelatine; the fibres are rendered very transparent, and the osseous granules are much more clearly seen.

B a 51. A vertical section of a portion of the ring of the same vertebra, in which the fibres are divided at right angles to their length: the entire surface is covered with dark spots, somewhat like bone cells, as shown in Plate II. fig. 21; these, however, have been ascertained to be the remains of cartilage cells existing between the fibres.

B a 52. A horizontal section of the ring of the same vertebra, made at right angles to the two preceding specimens: it shows that the fibres when divided in this direction are not always parallel, but connected at nearly equal distances by transverse bands, so that a framework of oblong meshes is formed, within which the remains of cartilage cells and their nuclei, as seen in the *Rhina*, Plate II. fig. 25, are sometimes visible.

B a 53. A horizontal section of one of the four masses of cartilage occurring in the bodies of the vertebræ of the same fish; it is composed of a hyaline substance, in which large oval nucleated cartilage cells are scattered irregularly. In some parts the cartilage appears opaque to the naked eye; this is owing to the presence of masses of fat imbedded in the matrix;

all the cartilage cells in the neighbourhood of the fat are full of oily matter.

B a 54. A tangental section of the ring of the vertebra of the same *Shark*, which has had its earthy matter removed by acid: the fibres are still plainly visible, and their outline has a granular appearance. The extremities of the fibres, as shown in Plate II. fig. 28, have a tendency to curl.

B a 55. A transverse section of the body of a vertebra of a *Shark*: it exhibits eleven rays proceeding from a ring surrounding the central opening, in which opening was lodged the chorda dorsalis; each ray is made up of two kinds of structure, the part nearest the centre being composed of circular bands, the other next the margin of radiating fibres; the intervening dark spaces making up the body of the vertebra, are in the recent state composed of cartilage, which has disappeared in drying, whilst all the rays are composed of ossified cartilage cells. This structure is shown in an early stage of development in all the dark parts of figs. 6 and 7, Plate I., and the preparation itself slightly reduced is represented in Plate I. fig. 29.

B a 56. The concave articulating surface of the same vertebra; it is made up of concentric rings of broad fibres, which are analogous in structure to those of the *Selache maxima* already described; this specimen is represented in Plate I. fig. 30; the annular structure appears to be common to the articular ring of nearly all the cartilaginous fishes.

B a 57. A horizontal section of the vertebral column of a Blue Shark, *Carcharias glaucus*: its articular surface is placed uppermost; the central part or body consists of a series of concentric rings composed of fibrous material, the remaining portion of cartilage. This preparation is represented of its natural size in Plate II. fig. 1.

B a 58. The corresponding half of the preceding preparation, having its horizontally divided surface uppermost; the centrum exhibits the bony radii, between which are masses of cartilage, showing a faint indication of a

laminated arrangement. This preparation is represented of its natural size in Plate II. fig. 2.

B a 59. A vertical section of a vertebra of the same fish, made in the direction of the line *a b*, Plate II. fig. 1 ; at *aa*, fig. 3, is shown the bony matter entering into the formation of the concave articulating surfaces, whilst at *b* is shown the cartilage making up the principal part of the body of the vertebra.

B a 60. A tangental section of the body of a vertebra of the same *Shark*, made in the direction of the line *a b*, Plate II. fig. 2 ; it exhibits the bony radii divided in a direction at right angles to their length ; the bony layers *aa*, fig. 4, with which the radii are intimately connected, are parts of the articular ring.

B a 61. A horizontal section of a portion of the body of the vertebra represented in Plate II. fig. 2 ; it includes a small part of the bony matter forming the articular ring; with this, portions of four radii are connected; the cartilage is composed of large, equal-sized, nucleated cells, arranged in parallel rows, between which are bundles of fibres. The bony portion is made up of a series of rings or ossifications, each of which surrounds a cartilage cell. The part forming the ring, on the contrary, is made up of broad fibres, between which are numerous oval interspaces, each inclosing the remains of a cartilage cell. A portion of the cartilage is represented in Plate II. fig. 5, and part of the ring in Plate II. fig. 6.

B a 62. A tangental section of a portion of the same vertebra, being taken in the direction of the line *a b*, Plate II. fig. 2. In this specimen both the cartilage and the radii are divided in a direction at right angles to those in the preceding specimen ; the cells of the cartilage are of the same size in both instances, but the fibres are now divided obliquely, so that they occur in conical bundles, which are occasionally crossed by others separating the rows of cells. This part of the preparation is represented in Plate II. fig. 9. The ossifying radius presents the same structure as that of the preceding specimen, the cartilage cell being gradually enclosed by a ring of bone; the portion of articular surface presents rather more

elongated meshes than the horizontal section, and the remains of the cartilage cells are also more elongated, as shown in fig. 10.

B a 63. A vertical section of a portion of the same vertebra, taken in the direction of the line marked *a b* in Plate II. fig. 1, and represented in fig. 3. The section includes a small piece of the ring *a a*, and the intervening cartilage *b*; the latter exhibits cells arranged in parallel rows, with broad, strong fibres between them, as represented in Plate II. fig. 7, whilst the bony articular surface shows the broad fibres divided transversely ; they exhibit a coarse hexagonal network, as represented in fig. 8, the meshes being occasionally occupied by dark angular masses, which appear to be the remains of the cartilage cells before alluded to ; some of these dark masses very nearly resemble bone-cells. This section corresponds with that of the *Selache*, B a 51, represented in fig. 21.

B a 64. A transverse section of the ring of a vertebra of a Shark, *Carcharias vorax*: it consists of parallel fibres of much greater breadth than those of the *Selache maxima*, but the quantity of earthy matter around them is exceedingly small: a portion of this preparation is represented in Plate I. fig. 2, as seen under a power of 150 diameters, and two of the fibres in fig. 3 under a power of 440 diameters : the inner concave margin is very transparent, and exhibits the nuclei of cartilage cells ; these are best seen close to the fibres.

B a 65. A horizontal section of the ring of the same vertebra, in which the fibres are divided at right angles to those in the preceding specimen : in some parts the cell-wall or circumference of each fibre is rendered opaque by the deposit of earthy matter, as shown in Plate I. fig. 18 ; in the other portions the fibres are divided more or less obliquely, and an irregular network, like that shown in fig. 19, is produced.

B a 66. A horizontal section of the vertebra of a Tope, *Squalus galeus*, taken in a direction at right angles to that of the length of the body of the fish ; this section, which is represented of its natural size in Plate II. fig. 11, shows that there is a tendency to form neurapophyses and hæmapophyses.

B a 67. A vertical section of the same vertebra made in the direction of the length of the body of the fish; this preparation is represented of its natural size in Plate II. fig. 13: at *a a* are shown the two articular surfaces; at *b b* the bony matter; this is quite solid, no trace of radii or of cartilage entering into its composition.

B a 68. A horizontal section of a portion of the same vertebra, made in the direction of that represented in Plate II. fig. 11; it includes a considerable part of the articular ring, but this is confined to the outer convex edge of the specimen, and may be known by the presence of strong fibres, having cartilage cells of peculiar figure between them, as shown in fig. 12; the inner concave edge, which forms part of the centrum of the vertebra, consists of rounded masses of cells, having the bony matter deposited in the tissue around them.

B a 69. A similar section, mounted in Canada Balsam, whereby all the parts composed of bone are rendered transparent, and all the oval and circular cells, which in the preceding specimen were black, are also transparent, and in many of them the nucleus is still present: the gradual transition from the circular cells to the elongated ones found between the fibres is well shown in this preparation.

B a 70. A vertical section of the vertebra of a *Tope*, made through the centre of the vertebra in the direction of the length of the fish, and corresponding with that of Plate II. fig. 13. It includes the parts entering into the articular ring; these may be known by their transparency, and when examined microscopically, will be found to consist of large circular cartilaginous cells, as shown in fig. 14, imbedded in a broad fibrous matrix; in the part composing the body of the vertebra, the cells are very much smaller, and in some places are so close together that the matrix cannot be observed.

B a 71. A corresponding section of the same vertebra mounted in Canada Balsam. In the articular ring are seen the large cartilage cells, which now appear to be in the middle of the broad fibres, and not between them; as we proceed towards the centre of the vertebra, there is a

delicate hexagonal network formed by the transverse division of the large fibres, some of these have a nucleus either in the centre or near the margin; all the parts composing the body of the vertebra are made up of large cells so closely packed that little or none of the matrix is visible between them.

B a 72. A tangental section of the same vertebra, having at each extremity a portion of the articular ring; this latter part is made up of large circular cells, a little nearer the centre, the cells become more oval; still nearer they are elongated, having a distinct matrix between them: in the other parts of the section the cells are either oval or circular, and so closely packed that scarcely any trace of the matrix can be seen.

B a 73. A corresponding section of the same vertebra, mounted in Canada Balsam; it exhibits precisely the same appearances as those of the last specimen, with the exception that the greater number of the cartilage cells are transparent, and in many of the elongated oval ones a nucleus may be plainly seen. This preparation, like all the others preceding it, clearly shows that the parts which in the dry sections were opaque, are not masses of osseous matter as might at first sight be supposed, but are either cartilage cells or the remains of them, and no doubt perform the same office as the bone cells in the osseous fishes, especially those which even now exhibit nuclei.

B a 74. A transverse section of the vertebral column of a large *Ray*, belonging to the genus *Rhina*; all parts except the centrum, are composed of cartilage coated with bone; the centrum is made up of the same dense bone as that of the Tope, *Galeus communis*. This specimen is represented of its natural size in Plate II. fig. 26, at *a* is seen the centrum, at *b* the neural, and at *c* the hæmal canal.

B a 75. A longitudinal section of the vertebral column of the same fish; all the ossified parts of the centrum are in the form of two cones having their apices joined, and known from the other parts of the vertebra by their white colour: this preparation is represented of its natural size in Plate II. fig. 27.

B a 76. A transverse section of a portion of one of the vertebræ of the same fish, taken from the part marked *a*, Plate II. fig. 26 ; the centre is composed entirely of cartilage, having a thin layer of bone on each margin ; the central cartilage cells are arranged in groups of five and six, but towards the edges, where ossification is going on, they assume a radiated form, there being a series of points of ossification occurring at regular distances throughout the specimen ; these present precisely the same appearances as those of the Thornback, *Raia clavata*, represented in Plate II. fig. 30, the matrix becoming ossified and enclosing the cartilage cells.

B a 77. A transverse section of the same vertebra, taken from near the part marked *b*, fig. 26, and including a portion of the ring or articular surface of the vertebra ; the outer edge of the section exhibits bone and cartilage of the same nature as that described in the preceding specimen, whilst the part corresponding to the ring is made up of the strong fibres similar to those represented in Plate I. figs. 2 and 17 : on careful examination, oval spots may be observed between the fibres ; these are not masses of bone as might be supposed at first sight, but are in reality cartilage cells, as will be shown in Preparation B a 85.

B a 78. A longitudinal section of one-half of the centrum of the same vertebra, taken from the spot marked *a*, fig. 27 ; the section includes a portion of the articular ring, which is divided in a direction at right angles to that of the fibres ; the appearance these last present is somewhat like that shown in Plate I. fig. 18, being made up of a series of hexagons, the thick walls of which are composed of bone, and the central part of a cartilage cell, occasionally exhibiting a nucleus.

B a 79. A section of the bony centrum of one of the caudal vertebræ of a large *Rhina*, made in the direction of the length of the body of the fish, the section itself being similar to that of the Blue Shark, shown in Plate II. fig. 3 ; it presents to the naked eye two different kinds of structure, one represented by *a*, composed of dense laminated bone, whilst the other, *b*, is softer and more transparent. When examined by a power of 250 diameters,

the parts marked *a* exhibit an immense number of minute cartilage cells arranged in a vertical direction, corresponding to the laminæ above mentioned; whilst in those represented by *b*, the cartilage cells in the centre correspond with those at *a*, but as we approach the circumference, the cells become larger and more widely diffused, so that a well-defined transparent matrix is visible, and in many parts traces of the walls of cartilage cells are very apparent.

B a 80. A similar section mounted in Canada Balsam; all the osseous parts are rendered transparent, and some of the cartilage cells also; others are filled with air, and appear black; these last serve to show the shape of the interior of the cell. Those forming the articular ring are small, and irregular in their outline, appearing somewhat like bone-cells, whilst those in the central part are larger and more or less oval: on the edges it may be noticed that the cells are compound, a great many small ones being enclosed within a larger one.

B a 81. A tangental section of the same vertebra, which also corresponds with that of the Blue Shark, fig. 4. It consists of two curved laminæ, which represent the articular surfaces of the vertebra, and of two vertical bands connecting the articular surfaces together; these last exhibit the same structure as the parts marked *b* in the preceding specimen, whilst the curved laminæ, like those of most sharks, exhibit a fibrous appearance; between the fibres however are elongated dark masses, which might readily be mistaken for bone-cells, but which in reality are modified cartilage cells, like those occurring in all other parts of the section.

B a 82. A similar preparation mounted in Canada Balsam, but placed on the slide so that the articular surfaces are in the direction at right angles to the preceding, as in specimen B a 80: all the parts composed of bone are now transparent, but many of the cartilage cells, or parts occupied by them, are filled with air, whereby the resemblance of these cavities to bone-cells is very apparent; the articular ring is readily known by the shape of its cells, which are always of an elongated oval form, the others being larger and more circular.

B a 83. A transverse section of a portion of the body of the same vertebra; the curved edge formed part of the articular surface, and like that of the preceding specimen is made up of broad fibres having elongated cartilage cells between them, whilst all the other parts of the section are composed of minute cartilage cells arranged in a radiated manner; this specimen is interesting as showing by the difference in character of the cartilage cells, the precise spot where the articular and non-articular portions of the bone meet.

B a 84. A similar section mounted in Canada Balsam; it is principally composed of the fibrous tissue entering into the formation of the articular ring, excepting the edge of the concavity, situated on the flattened margin of the preparation; this spot may be also readily known by the roundness of the cartilage cells, those in all other parts of the specimen being of an elongated oval figure.

B a 85. A horizontal section of the articular ring of a vertebra of a young *Rhina*, from which the earthy matter has been removed by acid; it consists of large fibres, between which are parallel rows of nucleated cartilage cells having a fusiform shape; in some parts of the section, as shown in Plate II. fig. 25, there is no trace of the broad fibres, but, on that edge in particular, which corresponded to the circumference of the ring, they are very apparent; this specimen affords conclusive evidence that the articular surface of the vertebra of most cartilaginous fishes is composed of a modified fibro-cartilage.

B a 86. A vertical section of the articular ring of the same vertebra, in which the broad fibres are divided in a direction at right angles to their length; this preparation, like the preceding, has been decalcified, and the nucleated cartilage cells are now seen in the midst of the fibres; they are of a round figure, in consequence of being divided in the direction of their short diameters. This section corresponds in situation with that of the Shark, Plate I. fig. 18, and would tend to prove that all the interspaces there shown were in the young state occupied by cartilage cells.

B a 87. A transverse section of the body of a vertebra of a fossil *Shark*, from

the London Clay of the Isle of Sheppey; all the parts that were originally composed of cartilage are now occupied by clay, whilst those that were bony and existed principally in the form of radii, are represented by brilliant metallic masses of sulphuret of iron.

B a 88. A section of the same vertebra, made sufficiently thin to be transparent; it is represented of its natural size in Plate II. fig. 24 *a*; all the parts originally occupied by cartilage cells are filled with sulphuret of iron, and appear black by transmitted light, whilst the clayey portions are of a light brown colour: a fragment of the section magnified 200 diameters is represented by fig. 24.

e. *Skeleton composed of Cartilage wholly or partially invested with an osseous crust.*

Nearly all the preparations illustrative of the structure of the skeleton of true cartilaginous fishes, and forming the subjects of description from B a 8 to B a 88 inclusive, have been taken from the vertebral column only; but in such descriptions no special mention has yet been made of an osseous crust, which in the Skates and Rays, and most other highly organized plagiostomous fishes, is found as an outer coating to the cartilage. In some species of Skate, and especially the common Thornback, the osseous crust covers every portion of a vertebra except its articular surfaces, but in the majority of Sharks it is best developed upon the cartilage of the cranium. It always presents a more or less hexagonal structure, each hexagon being capable of separation from its neighbours, especially in dried specimens. In young fish the crust is very thin, but in older individuals of the same species, it may become so thick that the hexagonal plates assume the form of prisms or cylinders; in fact, the greater part of the rostrum of the Saw-fish, as shown in Plate III. figs. 3 and 4, is composed of an aggregation of these hexagonal prisms. This crust appears in all cases to be made up of minute cartilage cells, arranged, as a general rule, in a radiating manner, and having transparent osseous material deposited in the tissue around them. It has been observed in a very early stage of development in a young Torpedo, just excluded from the egg, as shown in Plate I. fig. 26. In a young Dog-fish, having its allantoid bag still attached, the coating invested the entire cranium, and the hexagonal masses of cartilage cells were in the form of a connected

layer, as shown in Plate I. fig. 20. In many of the larger fishes in which the osseous crust exists, the margin of each prism or hexagon, as shown in Plate III. figs. 1 and 9, presents a more or less undulated character, and a dark structure occupies the spaces between them; this dark substance, as seen in figs. 1, 2 and 9, is traversed by numerous foramina, probably for the conveyance of blood-vessels; it is especially evident in the rostrum of the Saw-fish. When some of the hexagons are examined with high powers, a concentric arrangement of laminæ is very perceptible, and not unfrequently, especially where there is any tendency to a radiated disposition among the cartilage cells, radiating fibres may also be seen. When we examine the structure of the cartilage itself in these fishes, we find occasionally that there is a tendency to ossification in many parts; the mode of ossification, however, is so far peculiar, that it does not take place like that in the vertebræ of such fishes, by a calcification of the tissue around the walls of cartilage cells, as shown in Plate I. figs. 15 and 16, but by a deposition of minute equal-sized bony granules in and about the cells themselves, as shown in fig. 14.

B a 89. A portion of the cranial cartilage of a fœtal Torpedo, *Torpedo vulgaris*; it is made up of a mass of very minute cartilage cells, the upper surface of which is covered by a layer of partly ossified cells, somewhat resembling lacunæ in shape; this arises from the partial ossification of, and want of connection between two neighbouring masses of cells: the cell-walls are incompletely ossified, especially on the margins, whereby the resemblance to the canaliculi of lacunæ is produced; a portion of this preparation is represented in Plate I. fig. 26.

B a 90. A portion of the osseous layer removed from the cranial cartilage of a young Dog-fish, *Spinax acanthias*; it consists of a series of hexagonal cells of nearly uniform size, being on an average $\frac{1}{95}$th of an inch in diameter; each hexagon contains a large number of minute cartilaginous cells, arranged somewhat in the form of radii, the intercellular spaces being composed of osseous matter; part of this preparation, as seen under a power of 12 diameters, is represented in Plate I. fig. 20, and a single hexagon, under a power of 200 diameters, at fig. 21: in this last, the cartilage cells with their nuclei are well exhibited.

B a 91. A vertical section of the cranial cartilage of a Skate, *Raia Batis*; it exhibits, under a power of 20 diameters, a coating of osseous matter $\frac{1}{40}$th of an inch in thickness, divided at nearly equal distances by a series of vertical lines, indicating the walls of the hexagonal prisms; the cartilage, which is more than four times the thickness of the osseous layer, shows numerous nucleated cells. This preparation is represented in Plate I. fig. 35, the osseous crust being shown at *a*.

B a 92. A portion of the osseous layer removed from the cranial cartilage of the same Skate; it consists of a series of hexagons, visible to the unassisted eye; but when viewed by a power of 100 diameters, each hexagon is found to be made up of minute nucleated cartilage cells of an oval form, arranged in radiated parallel rows, the cells being on an average $\frac{1}{800}$th of an inch in diameter; in each hexagon there are, in some cases four, and in others six opaque bands which occupy a layer beneath the cartilage cells, and are composed of bony granules; these meet together in the centre of the hexagon: when this is viewed with a power of not less than 100 diameters, a large opaque star appears to occupy a situation below the cartilage cells; this structure is precisely similar to that found in the rostrum of the Saw-fish.

B a 93. A vertical section of a portion of cartilage forming the cranium of a Skate, *Raia Batis*; it is composed of a series of cartilaginous cells, arranged in groups, and imbedded in a structureless matrix; the cells are of an oval form, and contain one or more nuclei; a portion of this specimen, as seen under a power of 130 diameters, is represented in Plate I. fig. 13.

B a 94. A vertical section of the cartilage of the same fish, taken from a spot still nearer the cranial cavity; the cartilage cells are similar in size and shape to those of the preceding specimen, but the matrix, and in very many cases the walls of the cells also, are studded with minute granules: this specimen is interesting as showing the commencement of ossification, by the deposition of the osseous matter in a granular form; a portion of it is represented in Plate I. fig. 14.

B a 95. A portion of the cranial cartilage of a young Thornback, *Raia clavata*, exhibiting the investing osseous layer ; it is composed of a series of hexagonal cells, like those of the Dog-fish, which in point of development rank between the Torpedo and Dog-fish ; the hexagons are very perfect, but the ossification around the walls of the cartilage cells within the hexagons is as yet incomplete.

B a 96. A transverse section of a portion of the body of a vertebra of the same *Thornback* ; its outer surface is invested with an osseous crust ; its neural and hæmal canals also are coated with a similar layer. This section corresponds in a great measure with that of B a 36, and is represented in Plate II. fig. 29, but as yet the prisms are hardly distinct the one from the other, although each appears to have a separate centre of ossification.

B a 97. Three vertical sections of dorsal spines of the same *Thornback*, the external surfaces of which are covered by a layer of hexagonal osseous plates very like those of the Dog-fish, represented in Plate I. fig. 20 ; the spines themselves being made up of cartilage with ordinary nucleated cells. The diameter of the plates is on an average $\frac{1}{200}$th of an inch, and their thickness $\frac{1}{2000}$th; the cartilage cells are arranged in the form of radii, and the fact of their being surrounded by osseous material is well shown in this preparation, by some peculiarity most probably in the solution in which they are mounted, for everything that is of a bony character has assumed a red tinge; but the preparation is the more valuable, because the osseous crust can be so readily distinguished by its colour.

B a 98. A portion of the osseous layer removed from the cranial cartilage of an adult *Thornback* ; it is composed of a series of large, somewhat hexagonal plates, each of which exhibits cartilage cells arranged in four principal triangles like a Maltese cross. The preparation is mounted in fluid, and when viewed by a power of 100 diameters, displays a distinct concentric and radiated structure indicated by striæ following these directions. The sides of the so-called hexagons are sometimes indented ; these, with corresponding indentations in neighbouring plates, make up a series of foramina for the transmission of blood-vessels.



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B a 99. A portion of the osseous crust of an adult *Thornback*, which has been rendered thin enough to be transparent by grinding away its attached surface; it consists of a series of hexagons, occupied by minute cartilage cells arranged in a radiated manner. A portion of this preparation is represented in Plate III. fig. 21, as seen under a power of 25 diameters. When the cartilage cells however are examined with a power of 200 diameters, as shown in fig. 22, they are seen to be of irregular figure, and some of them have small offsets connecting them with their neighbours; these offsets appear to be rudimentary canaliculi. In some of the hexagons, the cells are arranged in a series of radii, and the same kind of offsets connect the cells together in a straight line; and if the process of coalescence of the cells had been complete, a tube like that of dentine no doubt would have been formed.

B a 100. A vertical section of the lower jaw of a Shark, *Lamna Cornubica*, covered on both sides by an osseous crust, and varying in thickness from $\frac{1}{8}$th to $\frac{1}{10}$th of an inch; it is composed of a series of vertical columns like those of the Thornback and Skate, each of which exhibits minute cartilage cells arranged principally in the form of triangles, with their apices meeting in the centre of the column. All the tissue between the cells is composed of firm osseous matter; the central transparent hyaline substance making up the mass of the section is cartilage, and some parts of it exhibit the cells with tolerable distinctness.

B a 101. A similar preparation mounted in Canada Balsam, whereby the cartilage cells both of the osseous crust and of the enclosed cartilage are more plainly seen than in the former one.

B a 102. A horizontal section of the osseous crust of the same cartilage, in which the columns are divided in a direction at right angles with their length. It will now be seen that they are of hexagonal or octagonal figure, and generally speaking, four of the sides join those of neighbouring hexagons, but the others have a tubular cavity passing obliquely between them and the contiguous sides of other hexagons. The cartilage cells occupying the centre of each of the hexagons are now seen to be disposed in the

form of radii; there is however a tendency in each hexagon to have cells aggregated together in the centre, and towards one edge of the section this mode of aggregation is so extensive as to fill the entire hexagon. The cells themselves are of an oval figure; they have the appearance of little beads strung upon a delicate wire, and in some cases there is an indication of two or more cells coalescing to form a line. If the most transparent parts between the cells be examined, a series of concentric laminæ may be observed.

B a 103. A vertical section of the jaw of a Shark, *Carcharias glaucus*, having a central part composed of cartilage and fibro-cartilage, the outer surfaces being invested by a thick osseous crust. It will be seen by the naked eye that the prisms of which the crust is composed are nearly cubes; their outer surfaces form a straight line, whilst their inner or attached surfaces are convex. This preparation, magnified 17 diameters, is represented in Plate III. fig. 17, and in it will be perceived all the points just mentioned: in each of the prisms the cartilage cells are arranged in the form of a Maltese cross, which is plainly seen in fig. 18, this being one of the prisms of fig. 17 magnified 50 diameters; the convex edge of this prism was the one attached to the cartilage, and its cells plainly exhibit the offshoots described in Preparations B a 99 and 102. Fig. 19 is a portion of the same prism magnified 200 diameters, in which the connection of the cartilage cells by means of the offshoots is well seen. The spaces left between the prisms were probably for the transmission of blood-vessels.

B a 104. A horizontal section of the osseous crust of the lower jaw of a Shark, *Galeus ferox*: like other specimens of the kind, it consists of cartilage cells arranged in a distinctly radiated manner, and from the section being mounted in Canada Balsam, a series of radiated and concentric laminæ can be seen when a high power is employed. Between each hexagon traces of large canals are visible; these are well shown at *a*, *a* in fig. 20, which is a representation of this preparation, magnified 25 diameters.

The osseous crust of some of the more highly organized cartilaginous fishes having now been described, and shown to be made up of a series of columns or prisms, it has been found convenient to take next into consideration the rostrum of the Saw-fishes, as this formidable weapon is almost wholly composed of the same tissue as that investing the soft cartilage of the cranium of the Sharks and Rays. According to Professor Owen*, in most of the Shark tribe "a conical projection or cut-water is continued from the fore-part of the head, and its framework is composed of peculiar and superadded cartilages, articulated to the anterior extremities of the frontal, nasal, and vomerine bones. These rostral cartilages (in the common Saw-fish, *Pristis antiquorum*) are blended into a horizontally flattened plate, which is produced to a length equalling one-third that of the entire fish; this process is more completely ossified than any other part of the skeleton, and a series of deep alveoli for the teeth is excavated in each of its lateral margins."

If a rostrum of *Pristis antiquorum* or *Pristis cuspidatus* be divided transversely, three or five foramina may be noticed as traversing the entire length of the rostrum; in the former species there are three foramina, one in the centre and one on either side; in the latter, however, there are, generally speaking, two foramina on each side of the central one, but that nearest the base of the teeth is frequently occupied by a pulpy substance. The central cavity generally contains firm cartilage, but the one on either side of it conveys branches of the facial artery and second division of the fifth pair of nerves to supply the teeth, and all the cartilage and bone in their neighbourhood. When the rostrum is divided horizontally, or in the plane of its own breadth, the spaces between the teeth in *P. antiquorum* are unossified, and a square chamber left, which will be found occupied by a mass of gelatinous cartilage; in *P. cuspidatus*, on the contrary, traces of the same shaped cavities will be found, but in almost every instance they are filled up with bone. The entire rostrum is coated on both surfaces with a layer of minute, somewhat hexagonal scales: these generally speaking are of a darker colour on the upper surface than on the lower; the scales lie upon a stratum of fibrous and horny tissue which invests the whole of the osseous portion of the rostrum, and is reflected inwards to line the sockets of the teeth.

* Odontography, vol. i. p. 40.

B a 105. A transverse section of rather more than half the rostrum of a Saw-fish, *Pristis cuspidatus*; the rostrum was upwards of two feet in length, and the section was taken from the middle. In the centre is situated an aperture the shape of a parallelogram, having its long diameter from above downwards; on either side is an oval foramen one-fourth of an inch in its long diameter: more external still there is another indication of a foramen, but its cavity is filled with soft cellular pith; the remainder of the section is occupied by a large sharp-pointed tooth. The edges of the specimen are surrounded by an enamel like layer of skin: when viewed with the naked eye, the section presents a very beautiful structure; around each of the cavities or foramina before noticed, there is a ring of bony matter more dense than the rest, and presenting a minutely radiated structure; external to these are arranged two or more layers of hexagonal prisms, precisely corresponding to those of the crust of the sharks and other cartilaginous fishes.

B a 106. A transverse section of a portion of the same *Saw-fish*, taken from a spot a little distance from the oblong central foramen, its centre being formed by the foramen through which passed the facial artery and the second division of the fifth pair of nerves: this preparation is represented of its natural size in Plate III. fig. 3; the layer *a*, forming the wall of the foramen, is made up of more dense prisms than those situated externally to it. When viewed with a magnifying power of 8 diameters, as shown in fig. 4, the three rows of prisms present a granular structure; the two outer ones precisely resemble the prisms of the Shark represented in figs. 17 and 18, the granular appearance being due, as in the Shark, to numerous cartilage cells; but the inner is very much more compact, and there is an approach to the formation of canaliculi and bone-cells: one of the outer prisms, as seen under a power of 25 diameters, is represented in fig. 5; and a portion of an inner prism, under a power of 130 diameters, is shown at fig. 6.

B a 107. A horizontal section of the rostrum of a Saw-fish, *Pristis cuspidatus*, taken from a spot a little below the skin on the upper surface of the rostrum. It consists of a series of somewhat hexagonal plates, each of

which is wholly or partially separated from its neighbour by an opaque substance apparently of a horny nature, and having numerous foramina, probably for the passage of vessels. The hexagons have undulating margins, and in structure are precisely similar to those of the osseous crust of the Sharks and Rays before described: in the centre the cartilage cells are the largest, and are aggregated together to form a mass of variable size, which is the white spot seen in the middle of each hexagon, and from which a radiated arrangement of smaller cells commences, and is continued to the margin of the hexagon. In some of the hexagons almost all the structure is radiated, and there appears to be something more required than the mode of disposition of the cartilage cells, to account for the fibrous appearance which such hexagons present. This preparation is represented in Plate III. fig. 1, under a power of 20 diameters, and a portion of one of the hexagons at fig. 2, as seen under a power of 100 diameters.

B a 108. A corresponding section to the one last described, from which the earthy matter has been removed by means of acid; it exhibits traces of all the cartilage cells, but the places in which the radiated structure was evident are still to be seen, although apparently made up of a wavy fibrous tissue; some of the fibres pass the boundary of one hexagon and enter that of another: in these last, the wavy character is most apparent. This preparation, as seen under a magnifying power of 25 diameters, is represented in Plate III. fig. 16, and the radiated structure spoken of is there indicated by fibres.

B a 109. A vertical section of the rostrum of the same *Saw-fish*, made in the direction of its length, and including one wall of the quadrilateral canal before mentioned: when viewed with the naked eye three distinct kinds of structure are visible; the upper and under surfaces are alike, and are the two rows of prisms which were noticed as surrounding the foramina in the transverse section; the two remaining portions occupy the centre of the section; that nearest the number exhibits no trace of hexagonal structure, but all the rest is made up of large hexagons, in which the cartilage cells are disposed in the form of radii.

B a 110. A vertical section of the same rostrum, taken between the two outermost foramina ; it presents two different kinds of structure visible to the naked eye, the upper and under surfaces being alike, whilst the middle is made up of a fibrous tissue, and is traversed by numerous canals, probably for blood-vessels and nerves.

B a 111. A similar section from which the earthy matter has been removed by means of acid ; the outer layers exhibit similar appearances to those of the hexagons described in the horizontal sections, but the part corresponding to the centre would tend to prove that all denominated fibrous in the preceding specimen is made up of minute cartilage cells. A portion of this preparation, exhibiting the structure last described, is represented in Plate III. fig. 10, and a still smaller part, under a power of 400 diameters, is shown at fig. 11.

B a 112. A transverse section including more than half the breadth of the rostrum of a Saw-fish, *Pristis antiquorum* ; the central cavity, which in *P. cuspidatus* was described as being of quadrilateral figure, or in other specimens of the same species having its centre occupied by a mass of firm cartilage, so as to divide the cavity into two, is in this preparation nearly filled up with cartilage : on either side of this cavity is a somewhat oval foramen, but there is not a distinct second cavity between it and the root of the tooth, as in *P. cuspidatus*. The bony prisms making up the mass of the rostrum, are the same as in *P. cuspidatus*, but the dense ring surrounding the foramen for the transmission of the vessels and nerves before mentioned, is not so well developed. If the rostrum had been divided in a horizontal direction through its teeth, certain square chambers would be found full of pulpy cartilage : in the section now being described, one of these chambers has been cut through, and the transparent substance occupying it is the cartilage above alluded to.

B a 113. A vertical section of the rostrum of the same *Saw-fish*, made in the direction of its length, and including the septum between the foramen for the vessels and nerves, and the quadrangular canal in the centre ; it is composed of large prisms, the outer being of quadrilateral figure, whilst

the inner are hexagonal, and differ in no respect from those seen in horizontal sections of the same rostrum.

B a 114. A similar preparation to the above, but including more of the septum between the foramina ; it has been macerated in acid in order to remove the earthy matter. All the hexagons with their radiated disposition of cartilage cells are well seen ; on approaching the point of junction between the hexagonal and fibrous layer, the walls of the latter disappear almost suddenly, but there is a kind of striated or zigzag arrangement marking out the hexagons, which is continued even into the fibrous portion, as shown in Plate III. fig. 15, this being a representation of the section taken about the middle.

B a 115. A horizontal section of the rostrum of the same *Saw-fish*, taken immediately below the skin; it corresponds with that of *P. cuspidatus*, B a 107, before described. To the naked eye, two distinct kinds of hexagons are visible, one much larger than the other ; on account of the section being made through the first and second layers of prisms, the largest hexagons exhibit little or no trace of cells in the centre, and the boundary wall of the hexagon is its most striking character; but in the smaller hexagons the most conspicuous part is the aggregation of cells in the centre to form a nucleus. When viewed with a magnifying power of 25 diameters, the boundary of each hexagon is very opaque, and the foramina not very evident ; the radiated arrangement of the cartilage cells is well-marked, but the cells in the centre are not much larger than those composing the radii in the smaller hexagons ; the aggregation of the cells in the centre, however, is so great as to render that part very opaque. A portion of this preparation is represented in Plate III. fig. 9.

B a 116. A vertical section of the soft bone found at the root of a tooth of a Saw-fish, *Pristis antiquorum* ; it consists of a fibrous frame-work, and of a mass of minute cartilage cells aggregated together and coated with osseous matter ; there are several foramina in the specimen, probably for the transmission of arteries and nerves to the base of the tooth. A part

of this preparation, magnified 50 diameters, is represented in Plate III. fig. 13, and a still smaller portion, magnified 200 diameters, in fig. 14.

B a 117. A portion of skin removed from the upper surface of the rostrum of the same *Saw-fish*, consisting of a series of nearly equal-sized scales of somewhat circular figure, having an opaque margin of a brown colour; the under surface of each scale is occupied by a large branching pulp-cavity, from which, numerous canaliculi like those of dentine, radiate towards the circumference. The canaliculi are best seen upon the free surface of the scale, but in order to observe the pulp-cavity, the under surface must be brought into focus. This preparation, magnified 100 diameters, is represented in Plate III. fig. 11, and it will be seen from it and the preceding specimens that the scales, although of somewhat hexagonal figure, differ very materially from the bone of the same fish, being in fact merely modified teeth.

f. *Vertebral column composed of Fibrous Tissue and a peculiar form of Cartilage.*

B a 118. The anterior half of a transversely divided vertebra of a Vaagmaer, *Vogmarus islandicus*; it exhibits the opening for the neural axis, and in its centre a circular spot about $\frac{1}{8}$th of an inch in diameter, from which fifteen radii are continued to the circumference, these are of a yellow colour, the intermediate tissue white; the central spot is occupied by flocculent matter, the remains of the chorda dorsalis.

B a 119. A transverse section of a vertebra of the same fish, taken a little nearer the articulating surface; in the centre a large opening may be observed, which in the recent state formed part of the articulating surface. This preparation, with the tissue surrounding the nervous chord, is represented of its natural size in Plate I. fig. 4.

B a 120. A transverse section of a portion of a vertebra of the same fish, which has been cut sufficiently thin to be transparent; it exhibits three of the radii which are found to be composed of rows of cells, in some cases single, in others two or more rows constitute a radius, they are of a circular figure, and through their walls a delicate transparent tube may be

traced, which passes through a foramen of much greater diameter than itself. The tissue between the cells is of a fibrous character, but there is no trace either of cartilaginous or of osseous tissue mixed up with it; a portion of one of the radii is represented in Plate I. fig. 5.

B a 121. A vertical section of the body of a vertebra of the same fish, in which the radii are divided in the direction of their short diameters; each radius is found to be made up of a bifurcating tube, in the walls of which may be noticed the foramina for the passage of the delicate vessel already described; in some of the foramina, small portions of it may still be seen. The use of this vessel cannot easily be determined; it probably may be for the purpose of supplying nutriment to the enclosed chorda dorsalis.

g. *Endo-Skeleton composed of Fibrous Tissue and Bone.*

B a 122. A transverse section of the body of a vertebra of a young Fishing-frog, *Lophius piscatorius*; to the unassisted eye it exhibits a radiated structure, the radii arising from a thin ring of bone forming part of the articular surface. When examined by a power of 250 diameters, it is found to be made up of two distinct kinds of structure, all the radii being composed of thin transparent osseous matter, and the intermediate substance of delicate fibrous tissue, without any trace of cartilage. This preparation, as seen under a power of 7 diameters, is represented in Plate II. fig. 15, and a portion magnified 100 diameters in fig. 16.

B a 123. A segment of a transverse section of the body of a vertebra from the same fish which has been allowed to dry, and distinctly shows the ossific matter, the fibrous structure having shrunk in the process; the bone is thin and transparent, and exhibits in one spot traces of lacunæ. A portion of the concave articular surface is left, which is composed of distinct fibres arranged in a concentric and radiated manner.

B a 124. A horizontal section of a vertebra from the same fish, taken in the direction of the length of the body; it is somewhat of the shape of an hour-glass; the two concave articular surfaces are each composed of a

thin lamina of bone, having a series of bony laminæ extending from the one to the other ; this preparation, magnified 7 diameters, is represented in Plate II. fig. 17, and a portion of the same magnified 100 diameters in fig. 18.

B a 125. A similar preparation to the one last described, which has been dried previous to being mounted in Canada Balsam ; the fibres composing it are disposed in the form of a network, different from that seen in the moist specimen, and the arrangement so nearly resembles the chorda dorsalis, as to be easily mistaken for it : the two articular surfaces are composed of fibrous tissue, the direction of the fibres being at right angles to the concave surfaces ; some portions of the thin bone below the articular surface present traces of oval bodies like bone-cells.

B a 126. A horizontal section of a portion of a vertebra of a large *Lophius*, exhibiting nothing but bony structure, the vertebra having been macerated and dried; the bone is not thin and transparent as in the specimens from the young fish, but minutely granular.

B a 127. A horizontal section of the coracoid bone from the same *Lophius* : to the naked eye this specimen exhibits two distinct kinds of bone, one exceedingly transparent, the other opaque, both being of the same thickness ; when viewed with a power of 250 diameters, the transparent portion exhibits no structure, but the opaque parts are all composed of granules, arranged in the form of parallel bands or fibres ; these take different directions in different parts of the section, and being in some cases divided longitudinally, in others obliquely and transversely, an appearance somewhat like that of bone-cells is occasionally presented.

B a 128. A transverse section of the same bone, traversed by a series of large canals, which in this specimen are divided transversely, the osseous matter being small in quantity, and forming the walls of the canals. In some parts it is transparent, but in others opaque and granular, resulting from the transverse division of the bands or fibres described in the last

preparation ; the thickest parts of the specimen are the most transparent and structureless.

B a 129. A segment of a transverse section of a vertebra of a Sun-fish, *Orthagoriscus mola*, made in a direction at right angles to the length of the body ; like the *Lophius*, it exhibits a radiated structure, the radii being composed of very thin laminæ of calcareous matter, firmly connected together by a distinct white fibrous tissue : when nitric acid is added to such a section, a slight effervescence takes place, the radii assume a wavy appearance, the intermediate tissue becomes corrugated, and strong connecting fibres are brought into view.

B a 130. A vertical section of the same vertebra, made in the direction of the length of the fish ; the parts corresponding to the radii now form an irregular network, the meshes of which are all more or less square, and from the sides numerous short fibres are given off ; many of these have curly extremities, and do not appear to have any connexion with the fibres between the radii, but project into the meshes like so many hairs or cilia.

B a 131. A tangental section of the same vertebra, in which all the parts corresponding to the radii are seen as so many broad bands ; each band very much resembling the horizontal sections of the articular ring of the cartilaginous fishes, in having minute oval cells between the fibres. When the transparent substance between the radii is carefully examined, strong branching fibres are seen ; these may be said either to be inserted into the radii or to arise from them, and are no doubt the same fibres as those described as projecting from the radii in the preceding specimen.

h. *Endo-Skeleton composed of Bone.*

B a 132. A longitudinal section of a vertebra of a Cod-fish, *Gadus morrhua*, consisting of transparent bony matter traversed by large Haversian canals : the bone is peculiar in consequence of its presenting a fibrous appearance, and might very readily be mistaken for fibrous tissue were it not for its density. No trace of bone-cells or canaliculi occurs in any part of

the section, and the skeleton of this fish might well be regarded as one composed of fibrous bone.

B a 133. A vertical section of a dense exostosis from the body of a vertebra of a *Cod-fish*, exhibiting the divided areas of many large Haversian canals; the bony matter between the canals presents in some parts a slightly granular, and in others a fibrous structure: there are no bone-cells or canaliculi present, although on the edge of the preparation nearest the name, the bone around the canals has a laminated arrangement.

B a 134. A transverse section of the same exostosis, exhibiting the bony matter around some of the canals in a laminated condition, whilst in a few of the others it is disposed linearly; neither bone-cells nor canaliculi are present.

B a 135. A thin section taken from the outer surface of the expanded portion of bone forming the head of a Light-horseman fish, *Ephippus*: the natural polished surface is uppermost, and exhibits a number of large canals divided transversely, all the bony matter between these is traversed by branching tubes, many of which appear to have an opening on the surface, but there is no trace of bone-cells.

B a 136. A thin plate of bone forming the head of the same fish; it has not been ground, and is seen to be largely supplied with minute canals, all of which pass in an oblique direction from the centre towards the circumference of the preparation, where they terminate.

B a 137. A transverse section of the thick portion of the cranium of an *Ephippus*; it is a cancellated structure, traversed by numerous large canals, around some of which, the bony matter is arranged in a laminated form; in those parts where the canals are fewest, the bone is supplied with branching canaliculi; no bone-cells, however, are present.

B a 138. A longitudinal section of the same part of the cranium of an *Ephippus*, differing slightly from the preceding specimen; some of the canals, however,

are divided in the direction of their length, and the branching canaliculi on one edge are in consequence very apparent.

B a 139. A transverse section of the expanded tubercle of one of the dorsal spines of a *Chætodon*; it consists of firm transparent bone, traversed by numerous branching canals, many of which open upon the surface, but there is no trace of bone-cells.

B a 140. A transverse section of the lower jaw of a fish of the genus *Sparus*; it consists of compact transparent bone, traversed by large Haversian canals, giving off numerous wavy radiating canaliculi, but without any trace of bone-cells.

B a 141. A longitudinal section of the same bone, in which the canaliculi are divided more or less obliquely, giving rise to an appearance like that found in fishes of the genus *Esox*.

B a 142. A vertical section of the lower jaw of a Parrot-fish, *Scarus*; it consists of transparent bone traversed by numerous large canals, some of which give off minute branches penetrating the thickest portions of the bone, but there is no trace of bone-cells in any part of the specimen.

B a 143. A portion of the cranium of a Flying-fish, *Exocetus volitans*: to the unassisted eye, certain longitudinal markings are evident, which, when examined microscopically, are found to be due to the presence of canaliculi, running transversely across the section; in this particular the specimen resembles that of the *Ephippus*, Preparation B a 135, but no bone-cells are visible.

B a 144. A portion of the operculum of a Red Gurnard, *Trigla cuculus*: on the edge nearest the name, the section is traversed by a series of large parallel canals which run in the plane of the bone, between them are others more minute, passing obliquely towards the margins, all the remaining parts of the bone are transparent and granular, and exhibit canaliculi divided transversely, but there is no trace of bone-cells in any part of the section.

B a 145. Another portion of the operculum of the same fish, exhibiting similar appearances to those of the preceding specimen, but in all the most transparent parts of the bone there is a peculiar appearance of oval bodies somewhat like large bone-cells without canaliculi: when viewed by daylight, they are of a slightly pink colour, and are probably nothing more than transparent spaces between a bony fibrous network.

B a 146. A transverse section of the lower jaw of a Wrasse, *Labrus variegatus*, made through one of the teeth, which may be readily seen at the end of the preparation nearest the name: the bony matter is transparent, and traversed in all directions by large canals, from which branching canaliculi are given off. The bone in the neighbourhood of the tooth, or perhaps what may be considered as the tooth itself, is traversed by equal-sized wavy tubuli like those of dentine; they end in a transparent layer, upon which the conical part of the tooth is situated; this last part is supplied with radiating canaliculi of large size.

B a 147. A longitudinal section of the same jaw, consisting of transparent bone in which the radiating canaliculi described in the preceding specimen are divided more or less obliquely, so that in some parts their entire length is seen, in others, the section being nearly at right angles, they have the appearance of bone-cells.

B a 148. A transverse section of a vertebra of an Electric Eel, *Gymnotus electricus*, consisting of laminated bony matter, which in some parts is traversed at right angles by branching canals: between most of the laminæ may be seen some elongated bone-cells, with radiating canaliculi coming off from them; the ossific matter is in a granular form.

B a 149. A longitudinal section of the same vertebra, exhibiting a laminated condition of the bony matter, and numerous canals and bone-cells divided in the direction of their short diameter. In the centre of the section is a fissure, one side of which, when examined with a power of 250 diameters, exhibits a cellular structure, being apparently composed of ossified cartilage-cells.

B a 150. A transverse section of a portion of the lower jaw of a Conger Eel, *Muræna conger*, composed of laminated bony matter, traversed by large vascular canals, some of which run at right angles to the direction of the laminæ, others are situated between them. On the edge of the section nearest the name, there are numerous black granular bodies arranged in a radiated manner; these are either canals or more probably bone-cells divided transversely.

B a 151. A longitudinal section of the same jaw of the *Conger Eel*, which like the preceding specimen exhibits to the naked eye a laminated appearance; when viewed with a power of 250 diameters, all the dark parts of the laminæ are composed of minute granules, traversed at right angles by nearly equal-sized canals full of opaque matter: if the transparent portions of the bone be examined, they will be found to exhibit a cellular structure, the cells being of various sizes, but their shapes rather too irregular for cartilage-cells.

B a 152. A transverse section of a portion of the lower jaw of another *Conger Eel*, composed entirely of laminated bony matter, the laminæ being of nearly uniform breadth throughout; they are traversed at right angles by large canals, and between them may be seen bone-cells divided transversely.

B a 153. A longitudinal section of the same bone, exhibiting bone-cells of the kind peculiar to fishes, arranged without any definite order, but having canaliculi freely anastomosing with those of the neighbouring bone-cells; some portions of the osseous matter are dark and granular, others perfectly transparent.

B a 154. A longitudinal section of a portion of the lower jaw of another *Conger Eel*, taken from a spot near the symphysis; it exhibits a large number of bone-cells of a quadrate figure, arranged in an indefinite manner, except in the neighbourhood of the Haversian canals, where they are placed in parallel rows: the bone-cells are mostly of an elongated form, resembling those of some Reptilia.

B a 155. A thin layer of bone taken from the lower jaw of a species of *Muræna*, exhibiting lacunæ of an elongated figure, somewhat like those in reptiles, and occurring in parallel lines ; these lacunæ are remarkable for the small size of the body of the cell, as compared with that of the canaliculi, they appear to be situated upon the surface of the bone, and nearly in one plane.

B a 156. Two fragments of the jaw of a fossil fish (probably allied to the genus *Muræna*), from the Chalk of Kent ; they exhibit a superficial layer of lacunæ of precisely the same character as those of the *Muræna* already described, the only point of difference being, that the latter are more elongated ; the lacunæ are confined to the surface of the bone, for in those parts which have been fractured, thin films of transparent bone may be occasionally seen immediately beneath the lacunæ, in which there is no trace of canaliculi. *Presented by J. Toulmin Smith, Esq.*

B a 157. Several small fragments from the same fossil jaw, in nearly all of which traces of lacunæ are visible ; a few of the transparent laminæ on the edges of the larger specimens however are destitute of them.

*Presented by J. Toulmin Smith, Esq.*

B a 158. A portion of one of the transverse processes of a vertebra of a *Conger Eel*, exhibiting lacunæ lying in different planes, and an intermediate structure presenting a series of tubuli like those of dentine : the lacunæ in the first or superficial layer have a quadrate body, and few canaliculi, as in fishes generally ; beneath this is the tubular structure occurring in wavy lines ; and still lower, as may be seen on the fractured edge, are lacunæ like those of the *Muræna* and fossil fish already described.

B a 159. A vertical section of the lower jaw of an Eel, *Anguilla acutirostris*, exhibiting on its lower margin a number of short canals, each of which terminates in, or becomes a lacuna ; some of these canals are divided in the direction of their long diameter, and measure $\frac{1}{2000}$th of an inch, others are divided transversely, when the canal resembles a lacuna, and the canaliculi come off from it in a radiating manner ; on the upper

margin of the specimen, the lacunæ are of the usual quadrate figure, but here and there dark patches may be observed, in which the canaliculi are exceedingly numerous ; these correspond to the situations of the teeth.

B a 160. Two rudimentary ribs of the same *Eel*, which have been reduced sufficiently thin to render them transparent ; the one which is most curved, exhibits a small number of lacunæ, but at either extremity may be seen a trace of a medullary cavity ; the other presents precisely the same structure as the jaw above described, its entire surface being covered by short canals, which have an opening on the outer surface of the rib at one extremity, and a series of branching canaliculi at the other. The bones of the Conger Eel differ from those of most other fishes in having lacunæ in certain places only ; the lower jaw is a remarkable instance of this kind, and it not unfrequently happens that all trace of them is confined to one or two spots near the symphysis ; the lacunæ in some situations have a very great resemblance to those of certain species of reptiles.

B a 161. A vertical section of the bones composing the vault of the cranium of a Gar-fish, *Esox belone* ; it is traversed by large canals, from all of which, numerous branching canaliculi are given off. On the convex surface of the specimen, small canals proceed from without inwards, at nearly equal distances from each other ; these give off branching canaliculi from their margins, which precisely resemble in their arrangement the branches of a tree : the same mode of distribution of canaliculi is constant throughout the specimen. Portions of the skeletons of two other fish, described in this Catalogue, namely, the Barracuda Pike and the *Fistularia*, Preparations B a 168 and 210, exhibit a corresponding distribution of the canaliculi, which may be considered as approaching nearer to the structure of tooth than of bone.

B a 162. A vertical section of a bone of the cranium of the same fish, made in the direction of the length of its body, in which, both canals and canaliculi have been divided more or less obliquely ; in some parts of the specimen, a canal with its canaliculi may be traced throughout its entire course, in

others both have been divided nearly transversely, and when the section happens to have passed through a canal near its bifurcation, it makes the latter appear like a lacuna.

B a 163. A horizontal section of another portion of the same cranium, in which all the principal canals and canaliculi are divided at right angles to their length; the consequence is, that we meet with parallel rows of short portions of canaliculi radiating from a black spot, which is one of the large branches of a canal divided transversely. If the canaliculi happen to be empty, their transverse sections will be seen as so many dark spots in all parts of the preparation; but all those that are full appear white: it is these last described spots which are so constant in the bones of all the Pike family hitherto described, and which have been shown to be due to the more or less transverse division of the smaller canals and canaliculi.

B a 164. A horizontal section of one of the cranial bones of a Gar-fish, *Belone vulgaris*; it exhibits the same appearances as those of the Common Pike, but both the bone and the oval spots present a much more granular appearance, the spots being smaller and more numerous.

B a 165. A transverse section of the snout of the same fish; it is of a greenish colour, and traversed by numerous branching canals, most of which proceed from the external towards the internal surface, and freely anastomose with others taking an opposite course, viz. from within outwards. In this specimen there are no minute canaliculi like those found in the vertical section B a 161 of the larger Gar-fish.

B a 166. A transverse section of the lower jaw of a large Pike, *Esox lucius*. To the naked eye it presents two kinds of bone, one clear and transparent, the other brown and granular; the section is traversed by large canals, around which the bone is arranged in the form of transparent laminæ, these last being crossed at right angles by faint radiating lines or canaliculi, presenting a granular appearance. The canaliculi are best seen in

the dark portion, but there is no trace of lacunæ in any part of the specimen.

B a 167. A longitudinal section made through the dense part of the bone of the same jaw; its entire surface is covered with numerous large oval spots, in some cases transparent, and presenting a greenish tinge; in others dark and granular: they always occur in parallel rows, and vary much in diameter; they may be considered either as sections of canals, or as lacunæ without canaliculi, but there is no trace whatever of them to be seen in transverse sections from the same jaw, neither is their appearance constant in all longitudinal sections; a portion of this section is represented in Plate I. fig. 8.

B a 168. A transverse section of part of the lower jaw of a Barracuda or Sea Pike, *Sphyræna Barracuda*. Like that of the Common Pike, it is composed of two kinds of bone, one hard and transparent, forming the outer layer of the bone, the other of a yellow colour and traversed by large canals. All the transparent parts are composed of laminæ, through which an innumerable series of canaliculi pass, their direction being from the canals in the centre towards the circumference; and should any large well-marked laminæ intervene, there is, generally speaking, either a dilatation or a bifurcation of the canaliculi at that part. Around some of the Haversian canals, the bony matter is deposited in concentric laminæ, but these parts of the bone are traversed by few canaliculi.

B a 169. A longitudinal section of the same jaw, exhibiting numerous canaliculi divided more or less transversely; in some parts of the preparation the Haversian canals run parallel with the section; in others, there is the same appearance as in the corresponding sections of the Common Pike and Gar-fish, Preparations B a 163 and 167, and it can be plainly seen that this curious structure results from the more or less transverse division of some of the larger canaliculi.

B a 170. A horizontal section of the lower jaw of another species of *Pike*, exhibiting dark granular masses like those above described: they occur in

parallel rows, and if all parts of the section be examined, it will be seen that these peculiar markings result from the more or less oblique division of large canaliculi.

B a 171. Two horizontal sections of a portion of the cranium of a Mackerel, *Scomber scombrus*. It will be noticed that those parts of the sections which are of a brown colour are thicker than the rest, and when examined by a power of 250 diameters, present a granular structure; the granules may be either like those of the Pike, B a 167, or the divided ends of tubuli: this latter appearance is best seen in the most transparent portions of the sections.

B a 172. A transverse section of a caudal vertebra of a large Tunny, *Thynnus communis*; it is composed of firm bony matter, and is most dense on the outer surface; the entire section is traversed by large branching canals, having their origin on the exterior; the osseous matter between the canals exhibits lacunæ divided transversely: on the inner edge of the section may be seen large canals like those of Havers, around which the bony matter is arranged in concentric laminæ, similar to those of the higher vertebrata; between some of the laminæ large lacunæ may be observed having no canaliculi.

B a 173. A vertical section through the dense outer part of the same vertebra, in which the large branching canals are divided at right angles to their length; they are arranged in parallel rows, and around each the bony matter is slightly laminated; all the tissue between the canals is occupied by lacunæ, measuring on an average $\frac{1}{400}$th of an inch in their long diameter; none of them present canaliculi.

B a 174. A vertical section of the same vertebra taken a little nearer the centre than the preceding; in the neighbourhood of the part coloured brown, large canals may be seen, which repeatedly send off anastomosing branches; the canals arise on the outer surface, and make their way towards the interior of the bone; between the branches may be noticed the elongated lacunæ, which are arranged in parallel rows, but like those of the preceding specimens, are without canaliculi.

The chief peculiarity of the bones of the Tunny consists in the presence of lacunæ of large size, without a trace of canaliculi being given off from any part: similar lacunæ are abundant in the scales of this fish. In the two last described sections the lacunæ are principally arranged in parallel rows, and are on an average $\frac{1}{2000}$th of an inch distant from each other; large branching Haversian canals are found in all parts of the bone, but there is no communication between these and the lacunæ.

B a 175. A transverse section of the rostrum or sword of a Sword-fish, *Tetrapturus belone*; it consists of a large number of vascular canals, proceeding principally in straight lines, and giving off numerous oblique branches from each side; around all the straight canals, the bone, which is very transparent, is arranged in a concentric manner, the margin of each concentric circle being white; there are no traces of lacunæ or canaliculi: this specimen is taken from near the apex of the sword, and the concentric arrangement of bone around the Haversian canals consists of one layer only.

B a 176. A transverse section of the same sword, taken from near the base; it presents precisely the same appearances as the preceding, except that the concentric arrangement around the Haversian system is more extensive, and a faint trace of radiated structure is observable in some of the largest concentric laminæ. This specimen is mounted in Canada balsam, consequently many of the smaller canals are obliterated, but the white line around each Haversian system resembles an undulating canal.

B a 177. A longitudinal section of the same sword, taken from near the apex; it consists of transparent bone, traversed by large parallel horizontal canals; these give off oblique branches at tolerably regular distances, so that the canals, when viewed with a power of 40 diameters, very nearly resemble in their arrangement the capillaries of muscular tissue; but neither in this nor in the preceding specimens is there any trace of lacunæ.

B a 178. A horizontal section of a portion of the cranium of a Dory, *Zeus faber*; all the thick parts of this section present the appearance of being made up of ossified fibrous tissue, similar to that of the *Selache* and other

highly organized sharks, the fibres being arranged in parallel lines; this structure is best seen in the median line of the section, on either side of which the fibres branch and become less regular, whilst the bone presents the same granular appearance as that of the Pikes, without any trace of canaliculi.

B a 179. A transverse section of the lower jaw of a Plaice, *Pleuronectes platessa*; it exhibits numerous Haversian canals, divided transversely and longitudinally, from all of which canaliculi are given off; these rarely branch, but all proceed towards the circumference of the section. In some parts the canaliculi are divided transversely, and present an appearance similar to that already described in the Pike genus.

B a 180. A longitudinal section of the jaw of the same fish; it exhibits numerous Haversian canals, divided principally in a transverse direction: from all the larger ones radiating canaliculi are given off, which proceed towards the circumference; in their course they are divided more or less obliquely, and this gives rise to some of the peculiar granular markings observed in the Pikes.

B a 181. A horizontal section of a bone of the cranium of the same fish; the greater part of its surface is covered with dark circular spots, in some situations resembling lacunæ, but in others being more like pigment; immediately below them are minute branching canals, with which the spots in question have no connection. In this preparation the natural surface of the bone is uppermost.

B a 182. A horizontal section of an operculum of a Perch, *Perca fluviatilis*, exhibiting numerous canaliculi, which have been divided in various directions, but no lacunæ: a minute granular structure like that alluded to in the bones of the Pike occurs also in this preparation.

B a 183. A transverse section of the body of a vertebra of the same fish; it consists of a mass of granular bone traversed by a few large canals, but exhibiting no trace of lacunæ.

B a 184. A horizontal section of a portion of the lower jaw of a Weaver, *Trachinus vipera*. All the thicker parts of the section are traversed by branching canaliculi, which are well seen in a projecting process of the bone. If the thin edge of this part be examined, in addition to the canaliculi, there will be seen some of the granular markings described in the Pike, Mackerel and Dory, but it is difficult to say whether they have any connection with the canaliculi, although most of the terminal branches run towards them.

B a 185. A portion of an operculum of a Roach, *Leuciscus rutilus*, which has been reduced sufficiently thin to be transparent; it consists of dense bone supplied with a great number of characteristic lacunæ, but without any trace of Haversian canals, except on one edge, where there is a large foramen, which might be considered as such; numerous canaliculi are given off from the lacunæ, freely anastomosing with each other and with those of neighbouring lacunæ.

B a 186. A longitudinal section of one of the pharyngeal bones of a *Roach*; it is traversed by numerous Haversian canals, and provided with lacunæ similar to those found in the operculum, most of them being remarkable for the large size and circular form of the cell itself; around many of the larger Haversian canals there is a slight laminated arrangement, and the lacunæ in the neighbourhood follow the course of the laminæ; in the other parts of the specimen they are arranged without much order.

B a 187. A transverse section of the corresponding bone, which exhibits a laminated arrangement, having numerous lacunæ between the laminæ, all of which have been divided in the direction of their short diameter.

B a 188. A longitudinal section of one of the vertebræ of the same fish; the central part exhibits a laminated structure, having numerous elongated lacunæ, like those of the Conger Eel. On one edge of the section the lacunæ are much more numerous, and are of a quadrate figure, like those found in the operculum.

B a 189. A portion of an operculum of a Dace, *Leuciscus vulgaris*; like the pre-

ceding specimen, it is composed of dense transparent bone, full of lacunæ, with numerous canaliculi which freely anastomose ; but there is no trace of Haversian canals.

B a 190. A transverse section of a pharyngeal bone of a *Dace*, being the corresponding section to that of the Roach, and like it consisting of a series of laminæ, between which are lacunæ divided in the direction of their short diameter.

B a 191. A transverse section of one of the vertebræ of the same fish ; it exhibits a laminated arrangement, and between the laminæ are elongated lacunæ, like those of the Roach, but the canaliculi given off from them are few in number. This preparation resembles a transverse section of a long bone from some of the smaller mammalia, where the medullary cavity performs the office of an Haversian canal ; the lacunæ in such sections being always arranged with their long diameters between the laminæ.

B a 192. A transverse section of one of the bones of the cranium of a Gudgeon, *Gobio fluviatilis* ; it consists of granular bone, traversed by minute branching canals, but without any trace of lacunæ or canaliculi.

B a 193. A longitudinal section of one of the vertebræ of a Gold-fish, *Cyprinus auratus* ; it is composed of firm bone, in every portion of which lacunæ are present ; they are arranged in rows parallel to the curved outline.

B a 194. A horizontal section of a rib of the same *Gold-fish*, showing traces of a central medullary cavity running the entire length of the rib : the walls of bone on either side of the cavity are firm and transparent, with elongated lacunæ arranged in parallel rows.

B a 195. A horizontal section of the operculum of the same *Gold-fish* ; the entire surface is studded with lacunæ of a quadrate form, from the angles of which numerous branching canaliculi are given off, freely anastomosing with those of the neighbouring lacunæ.

B a 196. A horizontal section of an opercular bone of a Bleak, *Cyprinus alburnus*, which is remarkable for the small number of lacunæ displayed; they are of a circular shape, and give off on all sides numerous very delicate canaliculi. Some of the larger lacunæ, like those of the Dace and Roach, present traces of nuclei in their interior.

B a 197. A portion of the gill-cover of a Carp Bream, *Abramis brama*, which has been reduced sufficiently thin to be transparent. It is largely supplied with lacunæ similar to those of the *Leuciscus rutilus* and *Leuciscus vulgaris*. On the edge nearest the name, the cells occur in several layers, the canaliculi of one layer anastomosing with those above and below; the lacunæ are of large size and full of granular matter, and in some of them a central spot resembling a nucleus may be seen; there are a few traces of Haversian canals, and around these the bone is arranged in a laminated manner.

B a 198. A transverse section of a neural spine of the same fish; the bone is made up of broad laminæ arranged concentrically; between the laminæ, numerous lacunæ are situated at tolerably regular distances; they are of small size, and give off few canaliculi, which run principally in the direction of the laminæ.

B a 199. A transverse section of one of the vertebræ of a Salmon, *Salmo salar*, made near one of the articulating surfaces. It consists of a ring of dense bone, exhibiting a few small lacunæ: the inner portion of the ring is slightly granular; but the outer, in some places, shows numerous parallel canals in addition to the lacunæ.

B a 200. A longitudinal section of a vertebra of the same *Salmon*; the portions of bone forming the articular surface are the most dense, and exhibit numerous lacunæ; the intermediate portions being all more or less granular.

B a 201. A horizontal section of the opercular bone of the same *Salmon*. It exhibits numerous lacunæ of the shape peculiar to fishes, distributed

without much order throughout the entire specimen; the canaliculi do not freely anastomose, and there is no trace of Haversian canals.

B a 202. A horizontal section of an opercular bone of a Trout, *Salmo fario*; it exhibits numerous lacunæ, which are mostly of an elongated figure, and having very few canaliculi given off from their sides. Their presence is not constant in all parts of the specimen, for where the bone is exceedingly transparent, there the lacunæ are wanting.

B a 203. A transverse section of the lower jaw of a Siluroid fish, from the Ganges; it consists of very dense bone traversed at right angles by minute Haversian canals, around each of which are one or two laminæ; all the intermediate tissue is supplied with lacunæ, having numerous canaliculi, which radiate from, not towards, the Haversian canals. Upon the convex margin of the section many of the canals are divided longitudinally, and in these parts the lacunæ are seen lying parallel with the canals; they are remarkable for the great number of canaliculi given off from their sides.

B a 204. A vertical section of the same bone, in which the Haversian canals are divided principally in the direction of their length; in some parts of the specimen they freely communicate with each other to form a network; and parallel with them are seen the lacunæ, which, like those of the preceding specimen, are remarkable for the large number of their canaliculi. The most transparent parts of the bone exhibit nothing but canaliculi, the central portion of the lacuna having been removed in the grinding.

B a 205. A thin plate of bone from one of the vertebræ of a Tobacco-pipe fish, *Fistularia tabaccaria*; it exhibits over the greater part of its surface numerous small quadrate lacunæ with very few canaliculi proceeding from them; nearly all of these, however, open upon the outer surface of the bone; in some parts may be noticed long canals which traverse the whole length of the section, and from their sides are given off branching tubes like enlarged canaliculi; these anastomose with the small cana-

liculi of the lacunæ, and also open upon the free surface, where their orifices are plainly seen: this preparation is represented in Plate IV. fig. 8.

B a 206. A similar preparation, but much thinner than the last; no large canals are present, nothing but the lacunæ, and these are widely diffused, except in one or two places.

B a 207. A similar preparation of one of the thin laminæ of a vertebra of a *Fistularia*, which exhibits better than either of the preceding specimens the true ichthyic character of the lacunæ. The edge nearest the name is thin and transparent, and the lacunæ few in number; as we approach the opposite end they become more numerous; the under surface of the section presents its natural appearance, being marked with small semicircular projections. A portion of this preparation is represented in Plate IV. fig. 10.

B a 208. A transverse section of one of the vertebræ of a *Fistularia*, taken through the centre of the body; it consists of a flattened ring of bone, from which four processes project, and is represented of the natural size in Plate IV. fig. 15. The part marked *a*, which may be considered the largest of the four processes, is represented in fig. 16, and is traversed by large parallel tubes, all of which communicate either with the external surface, or with large Haversian canals in the substance of the bone; the part marked *b* is represented in fig. 17, and exhibits numerous short canals like large lacunæ, from all sides of which branching canaliculi are given off,—an arrangement precisely similar to that occurring in the ribs of the Eel, and described in Preparation B a 160. The part marked *c* is represented in fig. 18; it exhibits a structure similar to that of *b*, but the Haversian canals having been divided transversely have a greater resemblance to lacunæ.

B a 209. A longitudinal section of the body of a vertebra of the same fish, exhibiting long parallel Haversian canals, from which innumerable branching canaliculi are given off. A portion of this specimen, as seen under a

power of 50 diameters, is represented in Plate IV. fig. 19; and another portion, magnified 200 diameters, in fig. 20.

B a 210. A transverse section of a portion of the lower jaw of a *Fistularia*, being remarkable for the beautiful arrangement of the canaliculi. It is traversed by large Haversian canals, which are divided transversely, and from the circumference of each the canaliculi arise, sometimes in the form of radii, at others in long wavy parallel lines; they do not give off many branches in their course, but each one bifurcates at its termination: the bifurcating branches generally occur at right angles to the main trunk, but they do not appear to communicate with neighbouring branches. This peculiar character of the canaliculi is shown in Plate IV. fig. 9, and a portion of the specimen, under a power of 50 diameters, is represented by fig. 11, and under a power of 200 diameters by fig. 12.

B a 211. A longitudinal section from the same jaw, in which most of the Haversian canals are divided transversely; the canaliculi are given off in a radiating manner, and their mode of communication with those of neighbouring canals is well shown. The anastomosis is not very frequent, but the terminal branching of the canaliculi is so abrupt as to present an appearance like a lacuna. A portion of this preparation, seen under a power of 50 diameters, is represented in Plate IV. fig. 13; and under a power of 200 diameters in fig. 14.

B a 212. A portion of one of the bones of the cranium of a Herring, *Clupea harengus*. It consists of very transparent bone traversed in some places by large canals, which in the section are divided vertically; there is no concentric arrangement of bone around the greater number of the canals, but the bone itself is largely supplied with lacunæ, remarkable for the great length of that part termed the body of the cell; they occur principally in parallel rows, and the canaliculi arise from the extremities of the cell; where the Haversian canals are well marked and the bone laminated, the lacunæ generally follow the direction of the laminæ.

B a 213. A horizontal section of one of the bones of the cranium of a Hassar fish, *Callichthys*; it is traversed by numerous large Haversian canals,

which form a coarse more or less hexagonal network, and from the sides of which numerous canaliculi are given off. When a canal is divided transversely, a slight laminated arrangement of the bone around it may be noticed; and when the space between the canals is great, the bone is supplied with lacunæ, from which numerous canaliculi are given off in a radiating form, freely anastomosing with those from the Haversian canals. In those parts in which the bone is laminated, the lacunæ follow the course of the laminæ.

B a 214. A transverse section of a portion of the snout of a Bony Pike, *Lepidosteus osseus*; it consists of dense transparent bone arranged in the form of broad laminæ around the Haversian canals; between some of the laminæ elongated lacunæ may be seen, but all the laminæ are traversed at right angles by small canals or tubes, which run from the circumference of the Haversian canal to the outer surface of the bone without branching. The two projecting processes on the outer edges of the section support a sharp pointed conical tooth.

B a 215. A longitudinal section of a portion of the same snout, in which are seen numerous Haversian canals having a laminated arrangement of bone around them, and branching canaliculi passing through them; these communicate with a series of characteristic lacunæ occupying all parts of the bone not laminated. The central portion of each lacuna is of a quadrate figure, and from the angles branching canaliculi arise, which freely anastomose with those of neighbouring lacunæ.

B a 216. A vertical section of one of the vertebræ of a *Lepidosteus*, made in the direction of the length of the body of the fish; it consists of dense transparent bone, largely supplied with lacunæ and tubuli, precisely similar in form to those in the scales of the same fish. The vertebræ of the *Lepidosteus* are very peculiar in having one articular surface convex and the other concave, which fact is well shown by this section.

B a 217. A transverse section of another vertebra of the same fish, consisting of finely laminated bone, having numerous lacunæ between the laminæ and branching canaliculi traversing the latter at right angles; both lacunæ

and canaliculi are precisely similar to those of the upper jaw, Preparation B a 214.

B a 218. A vertical section of one of the vertebræ of a *Polypterus* of the Nile, *P. Bichar*, made in the direction of the length of the body of the fish. It is traversed by large anastomosing Haversian canals, and all the intermediate tissue is supplied with lacunæ, which are remarkable for the great length and number of their canaliculi; these are so numerous in certain situations, as almost to obscure the lacunæ from which they are derived.

B a 219. A transverse section of a vertebra of the same fish, in which most of the large canals are divided at right angles to their length. It will be noticed that the bony matter is arranged in a laminated form around the canals, and only those parts that are most transparent exhibit the lacunæ to any advantage.

B a 220. A transverse section of a portion of a long bone of a fossil fish, *Megalichthys Hibberti*; it consists of a series of laminæ of bone, which form the walls of large Haversian canals; a few lacunæ may be observed between the laminæ, and from their size appear to have been divided transversely. A portion of this preparation, magnified 15 diameters, is represented in Plate V. fig. 1; a part of the same, under a power of 95 diameters, is shown at fig. 2; and some of the lacunæ, magnified 440 diameters, in fig. 3.

B a 221. A longitudinal section of a portion of the same bone, exhibiting a medullary central cavity, partly filled with some black substance; the bone on either side is largely supplied with lacunæ, arranged in parallel rows, they are of elongated figure, and nearly resemble those of reptiles. A portion of this specimen, magnified 95 diameters, is shown in Plate V. fig. 4; and a few of the characteristic lacunæ, taken from fig. 4, are represented in fig. 5, magnified 440 diameters.

B a 222. A vertical section of another portion of the same bone, taken from near the surface; the lacunæ are mostly similar in shape to those in the

preceding section ; but at one spot in the centre they appear to have been divided transversely, and will be found to be of the shape represented by fig. 3. The scales of this fish also exhibit lacunæ like those of the bone ; but there are other scales of large size from the carboniferous limestone of Burdie House, which have been mistaken for those of the *Megalichthys*. On microscopic examination, the lacunæ correspond in size with those of the *Rhizodus*, and it would appear, therefore, that these large scales cannot have belonged to the *Megalichthys*. A few of the lacunæ, for the sake of comparison, are represented in Plate V. figs. 13, 14 and 15.

B a 223. A transverse section of a portion of bone of a large fish, from the carboniferous limestone of Burdie House, near Edinburgh. It exhibits Haversian canals of great size, around which the bony matter is disposed in laminæ ; the lacunæ lie between the laminæ, and are remarkable for their length ; in those places in which the laminæ are disposed concentrically, the long diameter of the lacunæ may be seen, whilst in most other parts they are scattered irregularly throughout the bony matter, and are not unfrequently divided transversely. A portion of this specimen, magnified 95 diameters, is represented in Plate V. fig. 6 ; and another portion, magnified 440 diameters, is shown in fig. 7.

B a 224. A transverse section of the same bone, made thinner than the last. The concentric laminated arrangement is well seen in some parts, and the lacunæ are, in consequence, better displayed. Upon the margin there are no Haversian canals, but the laminæ follow the circumference of the bone. A portion of this preparation, magnified 95 diameters, is represented in Plate V. fig. 8 ; and a second portion, under a power of 440 diameters, in fig. 9.

B a 225. A longitudinal section of a portion of the same bone, in which the lacunæ are arranged in several planes, those in one plane crossing those above and beneath at various angles, from 20° to 90°. The lacunæ are remarkable for their very great length, and for their resemblance in arrangement to those of certain reptiles, especially the *Pterodactyle*.

A portion of this preparation, magnified 95 diameters, is represented in Plate V. fig. 10: another portion, magnified 440 diameters, in fig. 11: but in order to show the great length the lacunæ sometimes attain, an entire one is given in fig. 12.

For the sake of comparing the lacunæ in this Fish with those of the Pterodactyle, both have been drawn to the same scale; it will be seen that the lacunæ represented in figs. 10 and 11, Plate V., are nearly three times as long as those of the Pterodactyle, shown in figs. 26 and 27 of Plate IX.: the former measuring on an average $\frac{1}{160}$th of an inch in length by $\frac{1}{4000}$th in breadth, the latter $\frac{1}{400}$th by $\frac{1}{6000}$th.

B a 226. A transverse section of one of the bones of the cranium of a large fish, probably of the genus *Rhizodus*, from the carboniferous limestone of Burdie House. It exhibits numerous lacunæ, which are arranged in the same peculiar manner as those of Preparation B a 225, represented in Plate V. fig. 10. There are, however, two principal points in which the lacunæ of this fish differ from those above described: the first is, the small number of the canaliculi, the second, that the lacunæ are broader and not so long. A portion of this preparation, magnified 95 diameters, is represented in Plate V. fig. 16; another portion, under a power of 440 diameters, in fig. 17. *Presented by Robert Bryson, Esq.*

B a 227. A transverse section of a portion of the jaw of the same fish, exhibiting numerous Haversian canals, around which, the bone is arranged concentrically: the lacunæ are few in number, but present precisely the same characters as those of the specimen last described.

*Presented by Robert Bryson, Esq.*

B a 228. A vertical section of the outer portion of the jaw of the same fish; the bony matter is arranged in a series of laminæ, between which the lacunæ are sparingly scattered; some parts of the section present a granulated appearance, the others being transparent: in the latter the lacunæ are best displayed, but in none of them are the canaliculi very abundant. A portion of this preparation, in which the lacunæ are well

shown, magnified 95 diameters, is represented in Plate V. fig. 18, and a few of the lacunæ, as seen under a power of 440 diameters, in fig. 19.

*Presented by Robert Bryson, Esq.*

B a 229. A vertical section from the inner side of the same jaw, presenting similar characters to those in the last described specimen, but the lacunæ are much better displayed. The canaliculi, although more numerous than in any of the other preparations from the same jaw, are still very much less abundant than in the section, of which fig. 10 is a representation.

*Presented by Robert Bryson, Esq.*

B a 230. A vertical section of the same jaw taken from about the middle. It is by far the best section of the series, the lacunæ being tolerably numerous, and their canaliculi well shown; they are arranged principally in parallel rows, and on this account can be easily measured, the greatest length being $\frac{1}{200}$th of an inch, and the average breadth $\frac{1}{3000}$th. The canaliculi are so abundant in certain situations, as to give to the section a dark granulated appearance.

*Presented by Robert Bryson, Esq.*

B a 231. A transverse section of one of the long bones of a species of *Holoptychius*, from the coal measures of Gilmerton. It exhibits large Haversian canals, around which the bony matter is deposited in the form of laminæ, having elongated lacunæ between them; in all the other parts the lacunæ cross each other at various angles, and most of them are divided obliquely.

*Presented by Robert Bryson, Esq.*

B a 232. A vertical section of the same bone taken from near the outer surface, where the Haversian canals are absent. The section displays lacunæ in every part: near one edge they are arranged in parallel lines, on the opposite, they cross each other obliquely: the largest amongst them measure $\frac{1}{250}$th of an inch in the long, by $\frac{1}{2000}$th in the short diameter, and resemble those of Preparations B a 224 and 225, the former of which is represented in Plate V. figs. 10 and 11.

*Presented by Robert Bryson, Esq.*

B a 233. A vertical section of the same bone, including a portion of the centre, in which the Haversian canals are divided both obliquely and transversely. The lacunæ are best seen in the centre of the section, especially where the laminæ lie parallel to each other. On carefully comparing the lacunæ with those of the *Rhizodus*, they are found to be much broader in proportion to their length.

*Presented by Robert Bryson, Esq.*

# Division II.

## HISTOLOGY OF ANIMALS.

### Subseries XIV. *Exo-skeleton of Fishes.*

The exo-skeleton of Fishes varies considerably both in form and structure; in the Cyclostomi, as the Myxines and Lampreys, and even in many of the Eel tribe, it is composed of a firm fibrous tissue, but in the generality of instances it consists either of scales, bony plates or spines. The *scales* constitute the most common investment of the body of Fishes, being found either in an isolated condition, as in the Blenny, or in the form of a continuous covering, as in the Ostracions, Polypteri and Lepidostei. Scales differ very materially both in density and in intimate structure; they may be composed of a soft transparent flexible material like cartilage, either with or without the presence of osseous matter, or of highly organized bone, sometimes covered with a layer of enamel-like substance termed *Ganoin*. The *plates* and *spines* may be confined to particular regions of the body, the former being chiefly employed as a firm continuous covering to the head, whilst the latter are generally developed in connection with the fins.

For our knowledge of the minute structure of the scales of Fishes, we are principally indebted to the labours of MM. Mandl and Agassiz, and Professor Williamson, of Manchester. M. Agassiz has classified fishes by their scales; he divides them into four orders, viz. *Cycloid*, *Ctenoid*, *Placoid* and *Ganoid*. To the Cycloid order belong all those fishes which, like the Eel, Carp and Salmon, have scales of rounded form with smooth edges, and an upper surface more or less ornamented. The Ctenoid order embraces all fishes having scales the posterior margin of which is provided with spiny projections like the teeth of a comb, as in the Perch and Sole. To the Placoid order are referred those in which the scales are in the form of plates, some having a spine projecting from the centre as in the Rays, or the scales themselves resemble teeth, as in the Sharks

and Dog-fishes; whilst the last or Ganoid order includes all those fishes, as the Lepidosteus and Polypterus, in which the scales are bony and invested with a layer of ganoin on their external surface.

The minute structure of the exo-skeleton of Fishes has recently engaged the attention of Professor Williamson, who considers that a Cycloid scale is made up primarily of a superficial and a deep layer; the former consisting of two distinct structures, both impregnated with calcareous material, whilst the deeper layer is composed of a series of membranous laminæ. On making a section of a cycloid scale, as for instance, that of the Carp shown in Plate VII. fig. 14, the three layers are well seen, the upper one, *a*, being always more or less furrowed, the ridges and tubercles found upon the surface of such scales being due to this layer. The lower layer, *c*, is made up of a series of fibres arranged in parallel laminæ, the fibres in one lamina being inclined at various angles to those of the lamina above and below it, whilst the third or middle layer, *b*, is formed by an ossification of the membranous laminæ of the lower layer, and this process commences by the formation of certain lenticular bodies, shown at *aa* in fig. 13, which in process of growth become aggregated together and so form a separate layer.

Between the Cycloid and Ctenoid scales there is a considerable analogy of structure, and were it not for the tooth-like projections from the posterior margin of the Ctenoid scale, the other parts in both are very nearly alike. In the hard bony Placoid and Ganoid scales there is no constant character; such being the case, it has been considered advisable not to attempt a classification of the scales themselves, but simply to describe the most prominent features exhibited by each, and point out their resemblance to those of other scales, as well as to bone and teeth, which they so nearly resemble in their intimate structure and development.

It must, however, be borne in mind that the scales of fishes are not formed of cuticle or epidermis as the scales of reptiles, but are developed in the dermal layer or true skin; their basis, like that of bones and teeth, more nearly resembling cartilage than horn, and many of them, like teeth, possessing a well-marked pulp cavity.

The following series of preparations consist principally of the hard or bony scales and spines of fishes; the softer kinds, together with the pigmental

and other appendages to the skin, will be included in that portion of the Catalogue devoted to the Tegumentary tissues.

a. *Exo-skeleton composed of fibrous tissue without scales.*

B a 234. A portion of the soft exo-skeleton or skin of the Lancelet, *Amphioxus lanceolatus*; it consists of a series of delicate fibres arranged apparently in two planes, one nearly at right angles to the other: they are so minute and so close together, that light is decomposed on passing through them, and the entire specimen is in consequence beautifully coloured.

B a 235. A portion of the skin of a Lamprey, *Petromyzon marinus*, the dermal layer of which is composed of two strata of flattened fibres, crossing each other nearly at right angles. There is no trace of scales, but the cuticle exhibits numerous large stellate pigment-cells.

B a 236. A portion of the skin of a Chimæra, *Chimæra callorhynchus*, which, like that of the Lamprey, is made up of two layers of broad flattened fibres, both of which are well seen on the edges. No scales or pigment-cells are to be found on any part of the specimen.

b. *Exo-skeleton composed of thick skin in which detached circular scales are imbedded.*

B a 237. A portion of the skin of the Viviparous Blenny, *Zoarcus viviparus*; its upper surface exhibits circular depressions of a white colour, which are due to the presence of small round scales, about $\frac{1}{12}$th of an inch in diameter, each having a minute transparent spot in the centre, and presenting both concentric and radiating markings. These scales are seated deep in the cutis, like those of the Eel, and in some situations occur at tolerably regular distances apart, but they are rarely separated by less intervals than the $\frac{1}{20}$th of an inch.

B a 238. A series of minute scales detached from the skin of the Viviparous Blenny: each one is of circular figure, having a transparent structureless centre, around which numerous concentric rings are arranged: these are crossed by furrows or grooves radiating from the same centre.

B a 239. A series of scales detached from the skin of another species of Blenny;

they are of larger size than the preceding, and of oval figure. The central spot is small, and around it upwards of 30 laminæ are disposed, each of which is slightly elevated above the surface, and has its inner edge serrated.

B a 240. A portion of the skin of a common Eel, *Anguilla acutirostris*; it exhibits on its under or attached surface, a series of scales imbedded in a tough fibrous matrix; the scales do not overlap each other as in most of the osseous fishes, but are a small distance apart, they are of oval figure, and may be readily known by their cellular appearance: the black spots so abundant on all parts of the skin are cells of pigment. The scales in this class of fishes are so firmly protected by the cuticle, that they cannot be well seen until it is removed.

B a 241. One of the scales from the same fish, which very much resembles a section of the styliform process of the cranium of the Myxine, already described, being evidently composed of cartilage; it is of an oval figure, and $\frac{1}{4}$th of an inch in length. When viewed with a magnifying power of 25 diameters, it is found to consist of a series of more or less hexagonal cells of a nearly uniform diameter; the cell-walls are unusually thick, and in this they resemble the cartilage of the ear of the Bat; there are two small oval markings midway between the centre and margins of the scale, which seem to indicate lines of growth. This scale is represented of the natural size in Plate VI. fig. 1 A, and under a power of 12 diameters in fig. 1 B; a portion of the same scale, as seen under a power of 25 diameters, is shown in fig. 2, and another portion magnified 200 diameters is represented in fig. 3: in this last may be seen a number of granules situated in the tissue between the cell-walls, and also occupying the cavity of the cells; these have been described as the first trace of a deposit of osseous matter.

B a 242. A series of scales of a Sand Eel, *Ammodytes tobianus*; each exhibits a radiated and a laminated structure, the laminæ on one-half of the scale being much closer than those on the other; the latter structure resembles that of the common Eel, and is apparently made up of a series of

cells of a square figure. One of the scales of this fish is represented under a power of 40 diameters, in Plate VI. fig. 4: the coarse cellular portion above alluded to is represented by *a*, and the condensed by *b*; the latter was imbedded in the skin of the fish, the former one, *a*, being free.

c. *Exo-skeleton composed of soft flexible scales.*

B a 243. Two scales of a small Pike, *Esox lucius*; both are of an oval figure and about $\frac{1}{6}$th of an inch in their long diameter, the anterior portion, or that inserted into the skin, being readily known by its toothed margin. When viewed with a power of 250 diameters, the entire upper surface of each is found to be covered with raised markings, those in the centre being of irregular figure, but all the rest more or less concentric. On making a careful examination of the transparent material of which these scales are composed, a coarsely granular structure will be observed extending from the centre to within one-third of the margin; the granules are of a peculiar oval or boat-shaped figure, largest in the centre of the scale, and diminishing in size and becoming more compact as they approach the margin: some of them are isolated and more superficial than the rest, others appear as if they had been formed by the coalescence of two or more smaller ones; this is most evident in the granules nearest the centre. These peculiar granules evidently correspond with the lenticular bodies described by Professor Williamson as existing in the scale of the Perch, and are developed in the membranous laminæ of the scale.

B a 244. A scale of the same Pike, from which a portion of the under surface has been removed in order that the peculiar oval lenticular bodies may be more clearly displayed; they are arranged in laminæ, and vary considerably in size, the largest being about $\frac{1}{800}$th of an inch in the long diameter, the smallest not more than $\frac{1}{8000}$th. Many of the largest appear to be made up of two or more smaller ones; the coalescence most commonly takes place in the direction of the long diameter, but in some few instances it occurs at the extremities, and an elongated body is thus developed. There are none of these bodies on the edges of the scale, but

they are first found about $\frac{1}{30}$th of an inch from the margin and extend to the centre; at their commencement they are closely aggregated together, and are nearly as small as the osseous particles of bone, but gradually increase in size and become more widely separated as they approach the centre.

B a 245. Vertical sections of a scale of a larger *Pike*, each of which exhibits two distinct kinds of structure; the one external, as shown at *aa* in Plate VII. figs. 15 and 16, is composed of bony matter; the other, *bb*, which forms the internal layer of the scale, is made up of laminæ of a transparent structure like horn. The scale is thickest in the centre, as shown in fig. 15, and the free surface is furrowed in the manner represented at *a*: at both extremities of the section these furrows are so deep, that when divided vertically, they exhibit the appearance of spines, as seen at *a*, fig. 16. On carefully examining the lower strata of the osseous layer, where this latter comes into contact with the laminated portion, several of the lenticular granules or bodies described in the horizontal sections may be observed; these, like the osseous portion, are tinged with red.

B a 246. The scale of a large Perch, *Perca fluviatilis*, mounted with the lower or attached surface uppermost. The anterior margin is readily known by seven tooth-like projections, which, however, are not the processes distinguishing Ctenoid scales, these being situated on the opposite margin, but in the specimen under consideration they do not project far beyond the edge. When examined with a power of 100 diameters, numerous opaque markings of an oval figure and somewhat resembling the lacunæ of bone, are first seen; some of these markings are crossed by others at right angles, so that in certain spots a network having quadrangular meshes is produced. In the centre of the scale these linear markings are very numerous, and so arranged that lozenge-shaped or fusiform spaces, very much resembling both in shape and size the lenticular bodies described in the scale of the Pike, are left: these spaces, when examined by the polarizing apparatus, are found to be filled with calcareous matter. At the posterior margin of the scale may be seen the bases of four rows

of teeth, those in the outer row projecting from the edge in the form of spines.

B a 247. A horizontal section taken from the inferior surface of a scale of the same *Perch*; it consists of membranous laminæ, having between them numerous lenticular bodies resembling those described in the preceding specimen. In the centre of the section, which also corresponds to the centre of the scale, these bodies are of large size and generally occur singly; towards the margin of the scale they become smaller, and are closely aggregated together. The lenticular bodies, which at first sight resemble cells, are composed of carbonate of lime, and when treated with acetic acid an effervescence takes place and they wholly disappear, the membranous basis alone remaining; they are disposed in several planes and cross each other at right angles: none of them occur on the margin of the scales, but commence in the form of granules about $\frac{1}{20}$th of an inch distant from it.

B a 248. A vertical section of a scale of the same *Perch*, in which the superficial osseous layer can be well distinguished from the membranous ones beneath; the former presents a rough almost crystalline appearance, whilst the latter is made up of several broad laminæ, which are alternately structureless, and marked with vertical striæ. On examining the lower portion of this layer, the lenticular bodies before described are plainly seen imbedded in the membranous structure; they occur only in those laminæ which alternate with the structureless ones, and when they have coalesced, the vertical striæ observed in these particular laminæ are the result: it would appear, therefore, that the membranous portion of this scale becomes ossified by the coalescence of the lenticular bodies.

These lenticular bodies have been accurately described and figured by Professor Williamson; they occur in several planes, and are smallest and most numerous where they first appear, a short distance within the margin of the scale, and increase in size as they approach the centre, which increase is mainly owing to the coalescence of two or more small ones. It is through the development and mutual fusion of these bodies, between the membranous laminæ

in the central thickness of the scale, that this part becomes osseous as we find it: they do not exist in the scales of all Fishes, but are very abundant in those of the Perch.

B a 249. A scale of the Chub, *Cyprinus cephalus*; the upper surface is divided into four triangular segments, the anterior and posterior of which present both circular and radiating markings or ridges, the other two circular ones only. When viewed with a power of 50 diameters, the posterior or free margin can be readily distinguished from the rest by its covering of golden pigment. All the transparent portions of the scale near the centre, when carefully examined, exhibit traces of the lenticular granules. There are two other points of interest connected with the free portion of the scale, viz. the presence of stellate pigment-cells, and of a vessel full of blood.

B a 250. A scale of a large Carp, *Cyprinus carpio*, which, like that of the Chub, is divided into four segments; the anterior and posterior having both radiated and concentric markings, the superior and inferior concentric ones only. The concentric markings are peculiar in having small processes projecting from either side, which so nearly meet, that a four-sided space is mapped out; in the centre of the scale the space is completely surrounded by them: on carefully focusing the middle portion of the scale, lenticular bodies, similar to those found in the Pike, are brought into view.

B a 251. A vertical section of the posterior or free portion of the scale of a *Carp*: the upper osseous layer, as shown at *a* in Plate VII. fig. 14, is raised into spines (an appearance produced by the section of the ridges); the layer beneath, as seen at *b*, also contains osseous matter deposited in the laminæ, and along its lower edge distinct traces of the lenticular bodies are visible; the lowest or membranous layer, *c*, is composed of transparent laminæ having no definite structure.

B a 252. Two vertical sections of the scale of a *Carp*, which have been dyed of a rich crimson colour; the superior and middle layers are only slightly affected, but the lower membranous one is uniformly tinted.

B a 253. A large scale, said to be of the *Jew-fish* ; it is of an oval figure, an inch and three quarters in the long, and an inch and a half in the short diameter. The anterior portion, or that inserted in the skin, can be at once recognized by its radiated character, whilst the posterior or free margin is covered with a golden pigment : the centre of the scale exhibits a cellular appearance. Some of the scales of this fish are of circular figure, and precisely correspond both in external appearance and minute structure with the specimen described by Professor Williamson, as from the Bay of Dulse.

B a 254. A portion of the same Scale taken from near the posterior margin ; its upper surface exhibits the peculiar crack-like markings before described in the scale of the Perch ; some of these are opaque, others, filled with balsam, are quite transparent ; the concentric laminæ indicating the successive stages of growth of the scale are present, their edges being minutely serrated. When the middle layer of the scale is brought into focus, the lenticular granules are plainly seen ; they are small and closely aggregated together at their commencement, but towards the centre of the scale they are of very large size, measuring upwards of $\frac{1}{250}$th of an inch in length.

B a 255. A portion of the anterior margin of the same Scale, exhibiting to the naked eye a radiated structure, which is produced by a series of furrows. The radii are crossed by concentric laminæ, and are covered by the peculiar fusiform markings described in the previous preparation, some of which are so regular, that the surface is mapped out into a series of squares ; beneath these markings lenticular bodies of all shapes and sizes are very abundant ; some of them are isolated, others surrounded by minute opaque parallel striæ, which appear to be portions of the laminæ not infiltrated with balsam.

B a 256. Vertical sections of the same Scale, made in the antero-posterior direction, each showing very plainly the three laminæ of which the scale is composed. The superficial layer is in some parts very thin, in others, as represented by *a* in Plate VII. fig. 13, it is much thicker ; the middle

layer, *b*, is made up of lenticular granules of various sizes; those in the upper portion of the layer have coalesced, but the more deeply seated, *dd*, remain isolated: the lowest or membranous portion of the scale exceeds $\frac{1}{20}$th of an inch in thickness, and is composed of a series of parallel laminæ, between which, many of these lenticular bodies of various sizes, as shown at *ee*, are scattered; all of them have an opaque marking in the centre resembling a nucleus, and occasionally traces of concentric laminæ may be seen.

B a 257. A series of sections of the same Scale taken at right angles to the preceding: the only difference observable between the two being, that in the present series the lenticular granules are more clearly seen, and exhibit a better defined opaque spot or nucleus than the preceding.

B a 258. A horizontal section of the same Scale, which precisely resembles that of the Perch in exhibiting the lenticular granules arranged in various planes; all the larger ones have a linear marking in the centre, somewhat resembling a lacuna. The minute fibres of which the laminæ are made up are well displayed in this section.

d. *Exo-skeleton in the form of bony scales exhibiting lacunæ.*

B a 259. A vertical section of one of the scales of a Tunny (*Thynnus communis*), which measured upwards of 9 feet in length. Its outer surface is convex, its inner flattened, the intermediate structure being cancellated. When viewed with a power of 40 diameters, it is found to be made up of laminæ, between which elongated lacunæ may be observed. This section is represented of its natural size at *a* in Plate VI. fig. 6, and a portion magnified 40 diameters is shown at *b*.

B a 260. A horizontal section of the cancellated portion of a scale from the same *Tunny*. It exhibits numerous Haversian canals divided both obliquely and transversely; around these there is no trace of concentric laminated structure, the bony matter being occupied by a series of large lacunæ disposed in the form of radii. A portion of this preparation, as seen under a power of 25 diameters, is represented in Plate VI. fig. 7;

and another portion under a power of 130 diameters in fig. 8: in both these figures the radiated disposition of the lacunæ is well seen, and it will be remarked that the canaliculi are entirely absent.

B a 261. A horizontal section taken from the upper surface of the same Scale; it is entirely free from canals, but the lacunæ, which are also remarkable for having no canaliculi, are arranged in a peculiar order, as shown under a power of 130 diameters in Plate VI. fig. 5: this arrangement of the lacunæ is probably due to their being disposed in several planes, those in one plane being placed at angles of 45° and less, with those of the contiguous layers. A similar disposition of the cells has already been described as existing in the bones and scales of the *Rhizodus*, as shown in Plate V. figs. 10, 11 and 16; and a somewhat similar distribution occurs also in the Frog, Newt, and Pterodactyle amongst the Reptiles: from all these, however, the lacunæ of this fish may be distinguished by the absence of canaliculi.

B a 262. A portion of the bony case of a small Trunk-fish of the genus *Ostracion*; it consists of a series of plates of hexagonal figure and light brown colour; each plate is slightly convex in the centre, as shown at *a* in Plate IV. fig. 6, the margins are scalloped, and the entire surface is covered with a series of undulating lines, which indicate the successive stages of growth of the scale. The scales are connected firmly together by their scalloped edges, and the raised centre of each appears as if ossification had commenced in it, and was extending by numerous radiating lines towards the margins. The scales are covered by a thin cuticle, in which minute stellate pigment-cells may be observed.

B a 263. A portion of the bony case of another Trunk-fish, *Ostracion triqueter*, including one perfect scale and parts of two others. The centre is slightly raised, and surrounding it is a series of large canals; these, after a few bifurcations, terminate in small nearly parallel trunks, from the sides of which minute branching canaliculi are given off. This preparation, magnified 8 diameters, is represented in Plate IV. fig. 1, and the distribution of the principal trunks shown; in fig. 2, which is a portion

taken from near the margin, the parallel trunks giving off very minute canaliculi, are exhibited under a power of 130 diameters.

B a 264. A portion of the bony exo-skeleton of another Trunk-fish, *Ostracion cornutus*, including five perfect scales and parts of six others. The sutures between each are not serrated as in the two preceding specimens, but are of uniform size, and appear like tubes filled with dark matter. In the centre of each scale the remains of large canals are seen, but they cannot be traced to the margin; all the other parts of every scale are occupied by lacunæ, those in the centre being of quadrate figure, but near the margins they are disposed in parallel rows, and their canaliculi are so numerous and so straight in their course that they render this part of the scale opaque; it is these canaliculi which constitute the *lepadine* tubes of Professor Williamson. A portion of this preparation, as seen under a power of 7 diameters, is represented in Plate IV. fig. 3, and a small piece from the centre of one of the scales showing the lacunæ, under a power of 250 diameters, in fig. 5. In fig. 4 is seen the general arrangement of the lacunæ and their canaliculi under a power of 130 diameters.

B a 265. A small circular scale from the middle line of the body of a Bony Pike, *Lepidosteus osseus*, with its outer natural surface uppermost: this surface is smooth and shining, and has been compared to the enamel of teeth; but as it differs materially in structure from this substance, the term *Ganoin*, given to it by Professor Williamson, is far preferable. When viewed with a power of 25 diameters, four distinct structures are visible; the most conspicuous are large concentric laminæ near the margin, which probably indicate different stages of growth. The next structure consists of circular spots, which correspond with the funnel-shaped extremities of the large tubes, as described in the scales of the Hassar-fish. The third variety is a radiated arrangement of tubuli having branched extremities, and the last structure is that of lacunæ of the ordinary form. A segment of this scale, magnified 25 diameters, is seen in Plate VI. fig. 16; and a portion of the same, magnified 130 diameters, in fig. 17. When the free surface of the ganoin is examined

with a power of 130 diameters, as shown in fig. 18, a minute granular structure is perceived, and two sets of open-mouthed tubes can be plainly recognized, one set large and funnel-shaped, the other much smaller, being the terminations of the radiated tubuli. All the intermediate structure of the scale is supplied by lacunæ.

B a 266. A horizontal section of the same Scale, which has been reduced sufficiently thin to be very transparent, by grinding away both the upper and under surface. It exhibits the canals and tubes divided transversely, besides numerous lacunæ of the usual quadrate figure, and others more elongated, from which the parallel canaliculi before described are given off.

B a 267. A vertical section of a thick scale of a *Lepidosteus*, showing to the naked eye two distinct kinds of structure, the upper and outer layer being composed of ganoin. The great bulk of the scale is formed of transparent bony matter, in which are numerous radiating tubuli, lacunæ, and exceedingly fine canaliculi. The upper edge is slightly serrated; it supports the ganoid layer previously noticed, and is composed of a series of undulating laminæ, the breadth of which, as shown at *a* in Plate VI. fig. 19, corresponds with the serrations of the bone below; the tubes of this layer are continued into the ganoin; the greater number however seem to be lost before gaining the free surface of the latter, but certain large canals, corresponding with those seen in the previous preparation, may be traced through all the laminæ. This preparation is represented in fig. 20, under a magnifying power of 7 diameters, a portion of the central part, under a power of 40 diameters, in fig. 21, and a segment of the inferior edge in fig. 22. The dark lines indicated in this last figure are produced by minute canaliculi, which appear to be derived from numerous lacunæ in the neighbourhood.

B a 268. A horizontal section of a scale of the same *Lepidosteus*, from which the upper or ganoid layer has been removed. Two kinds of lacunæ may be distinguished, one of quadrate form arranged at certain regular distances, and showing an anastomosis of canaliculi; the other much elongated,

and having canaliculi so numerous as almost to obscure the body of the lacuna from which they arise.

B a 269. A vertical section of a scale of a Siluroid Fish. The upper part is formed by a layer of the peculiar enamel-like substance, termed *Ganoin*, about $\frac{1}{20}$th of an inch in thickness; it is composed of well-marked laminæ, not extending the entire length of the margin, but ending abruptly in a serrated edge. The layer of bone lying underneath is laminated and contains lacunæ, and from these, fine radiating canaliculi pass off, which correspond to the tubular structure called *Lepadine* by Professor Williamson. The laminæ are also traversed by larger tubes, like those of the *Lepidosteus* represented in Plate VI. figs. 16 and 17; some of them may be clearly traced into the ganoid layer. This preparation, in its general character, resembles that of the scale of the *Lepidosteus* shown in figs. 20 and 21.

B a 270. A vertical section of a scale of the *Polypterus*, from the Nile, *P. niloticus*; it exhibits two distinct layers, like the scale of the *Lepidosteus*; the one composed of transparent laminæ of ganoin, the other of ordinary bone supplied with Haversian canals, lacunæ and tubuli. The ganoid layer is exceedingly thin, and consists of but three laminæ, which do not cover above two-thirds of the surface of the scale; the upper edge of some of the laminæ exhibits a granular structure, like that described as existing upon the free surface of the Lepidosteus, and represented in Plate VI. fig. 18: a few large canals traverse this layer, but there are no tubuli, as in the *Lepidosteus*. The osseous layer composing the remainder of the scale is largely supplied with canals, which run in various directions; some from the inferior edge towards the margin, others from the ganoid layer towards the middle of the scale; they all give off numerous canaliculi, which freely anastomose. The lower edge of the scale exhibits numerous laminæ, between which are lacunæ of elongated figure, and from them proceed canaliculi running in parallel directions, like the tubuli of dentine: these correspond to the Lepadine tubes of Professor Williamson.

B a 271. A horizontal section of the scale of the same *Polypterus*, in which may be seen portions of the two layers described in the vertical section. On the corner nearest the name, may be observed the granular structure characteristic of the free surface of the ganoin, with the circular ends of the large canals. Proceeding towards the opposite side of the scale, the canals will be seen to give off numerous canaliculi; in the centre they form a coarse network, as in the Hassar-fish, and in the interspaces lacunæ are found. All the other parts of the scale, especially those that are most opaque, exhibit the parallel tubuli of lepadine described above.

B a 272. A horizontal section of a scale of a Hassar-fish (*Calichthys*). On viewing this preparation with a power of 100 diameters, the first thing that strikes the observer is the presence of large canals running in the plane of the scale: these so frequently communicate with each other by transverse branches, that a network composed of large square meshes is produced; in other parts of the section, some of these canals are divided nearly transversely, and around them a laminated condition of the bony matter may be observed. Every portion of this preparation is supplied with lacunæ of remarkable beauty, the centre or body of the cell being very small, but the canaliculi very numerous and exceedingly long and delicate; they anastomose so frequently with each other that they cover the section somewhat like a spider's web.

B a 273. A vertical section of a scale of the same fish, which may be distinctly seen to be made up of three separate layers, somewhat resembling a section of a cranial bone in their arrangement; the upper and lower layers or tables being composed of a series of laminæ having lacunæ between them, whilst the central or diploic portion is cancellous, being permeated by the large canals described in the preceding section: it will be noticed that they traverse the compact layers at right angles. In the upper or convex layer there are upwards of twenty canals, which come from the diploë: in the lower concave layer, or that in close proximity with the skin of the fish, the canals are divided vertically, and are fewer in number, there being sufficient however to demonstrate that this part possesses considerable vascularity. The lacunæ are well seen in certain

portions only of the preparation, in consequence of their lying between the laminæ of the compact layers, but it may be observed that the laminæ are traversed at right angles by canaliculi.

B a 274. A portion of one of the scales of the same fish, which has its outer surface uppermost; the scale itself is in its natural condition, not having been reduced in thickness to render it transparent, so that the arrangement of the canals and lacunæ is in an undisturbed state. On bringing the upper surface of the scale into focus, the large canals may be well seen: they are filled with brown matter, having much the appearance of altered blood; many of them may be traced to the external surface, where they terminate in a funnel-shaped extremity, around which is a clear transparent ring of bone. When the central portion of the scale is brought into focus, it will be seen that the canals form the network described in Preparation B a 272, and a few branches may be traced as passing down to the under surface. All parts of the bone not occupied by canals, exhibit the lacunæ in great perfection; but they appear to be the most numerous in the lowest table, which, like the corresponding part in the cranial bone, is of more compact texture than the outer.

B a 275. The corresponding portion of the same Scale, with its lower or deep surface uppermost. It will be seen that this layer is much more compact than the upper one, and more largely supplied with lacunæ. The mouths of the canals are distinctly visible, but they have not the same funnel-shape as those described on the external surface.

B a 276. A horizontal section of a scale of the *Hassar-fish*, in which the large canals of the middle or diploic layer are well shown; they form a complete network, and in their interspaces the lacunæ are plainly exhibited. A portion of this preparation, magnified 130 diameters, is shown in Plate VI. fig. 14.

B a 277. A vertical section of the same Scale, made in the direction of its short diameter; it shows very well the three layers before spoken of, the upper being more opaque and rougher on its free surface than the lower. The canals in the diploë are very numerous, and a slight tendency to a lami-

nated arrangement around each may be well seen. This preparation, magnified 40 diameters, is represented in Plate VI. fig. 13; the upper rough edge formed the outer surface of the scale.

B a 278. A vertical section of the same Scale, made in the direction of its long diameter: the different layers are well shown, but the most interesting feature in the section is the arrangement of the canals; these will be found to run principally in the long direction of the scale, and to give off branches at right angles, which pass through the laminæ both to the upper and lower surface of the section; those distributed to the latter will sometimes be found to divide into numerous canaliculi. This preparation, magnified 40 diameters, is represented in Plate VI. fig. 15: the lacunæ are well displayed in the lower layer.

B a 279. A vertical section of a large brown scale of a fish probably belonging to the genus *Holoptychius*, from the carboniferous limestone of Burdie House, near Edinburgh. The upper third is composed of laminæ, in which may be seen lacunæ arranged in different planes; below these, in the middle third, the lacunæ lie in the plane of the section; the inferior third exhibits Haversian canals, around which the bony matter is disposed in laminæ having lacunæ between them. The diameter of the preparation itself is three quarters of an inch, and its thickness one-twelfth of an inch.

B a 280. A vertical section of the same Scale, taken nearer to the centre than the last, being an inch in length, and one-twentieth of an inch in thickness. The cancellous structure is seen in the middle of the specimen, but at the extremities the laminated portion only is present: on the edge nearest the name, the laminæ are parallel to the surface; at the opposite extremity, they are inclined at an angle of 45°. In the centre, the middle layer is more developed than the other two, and in it the lacunæ are well displayed.

B a 281. A horizontal section of the same Scale, exhibiting a series of parallel lines $\frac{1}{4000}$th of an inch apart, crossing each other at right angles; some of these lines are dilated at intervals, and an appearance is produced

precisely like that of a lacuna; canaliculi, or lines corresponding to them, are also present, these being derived from a dilatation of the cross striæ close to the body of the cell; and from the balsam not having entered the striæ, all these parts are dark like lacunæ. This section has been made in the plane of the laminæ, described in the vertical section as forming the upper third of the entire thickness of the scale.

B a 282. A horizontal section of the same Scale, exhibiting lacunæ of large size arranged in a series of planes, those in the centre of the specimen being most plainly seen. On the edge nearest the name, the striated character described in the preceding preparation is very evident; but however much the peculiar markings in that situation resemble lacunæ, they will be found very unlike those which are undoubtedly such.

B a 283. A chipping taken from the upper surface of the same Scale, which exhibits very distinctly the two sets of striæ before described; they cross each other at right angles, and many of them are dilated at regular intervals, whereby a considerable resemblance to lacunæ is produced.

B a 284. A series of chippings from the same Scale, in some of which a similar structure to that of the preceding specimen is exhibited, but in others undoubted lacunæ are present; these lie in several planes, and those in one plane are generally placed at an angle of 45° with those lying beneath. Some of the lacunæ are of rounded figure, and occur in situations presenting no trace of planes. A portion of this preparation is represented in Plate V. fig. 13: the two forms of lacunæ are there shown under a power of 95 diameters; the elongated form, occurring in planes, is seen in fig. 14, the rounded form in fig. 15.

B a 285. A vertical section of a very large Scale, said to be of *Holoptychius*, from the carboniferous limestone of Gilmerton, near Edinburgh: there are portions of three other scales visible in the same section, but attention will be particularly directed to one seen in the middle, as being the most perfect. One edge of this section, which I shall consider as the base, presents a cancellated structure, and is composed of large canals

divided more or less transversely; around these the bony matter is disposed in the form of laminæ, having numerous lacunæ between them. The anterior or upper surface of the section consists of a series of parallel laminæ, every alternate one presenting the same structure; in one set of these laminæ, the lacunæ, which are of large size, run in parallel lines, in the other they are arranged more or less obliquely: this character is constant in all three sections. *Presented by R. Bryson, Esq.*

B a 286. A horizontal section taken from the base of the upper scale alluded to in the preceding preparation; it exhibits many large canals divided both transversely and obliquely, around which the bony matter is arranged in laminæ with numerous lacunæ between them; these last are principally of the globular variety, the elongated ones being altogether absent. *Presented by R. Bryson, Esq.*

B a 287. A horizontal section from the middle portion of a scale of another specimen of *Holoptychius*. On the side nearest the number are seen the Haversian canals divided transversely, with the globular form of lacuna around them; on the opposite side of the section there are no Haversian canals, but elongated lacunæ arranged in parallel lines.

B a 288. A horizontal section of the same Scale, made in such a way as to include two of the parallel laminæ described in the vertical section: the entire surface exhibits lacunæ of the elongated form, arranged nearly at right angles to each other. In some parts, the striæ alluded to in Preparations B a 281, 282, are very evident, and false lacunæ accompany them.

B a 289. A horizontal section of the same Scale, in which elongated lacunæ are found arranged in a series of narrow bands, generally at right angles to each other. One plane of striæ occurs in each band, and the lacunæ follow the direction of the striæ.

B a 290. A vertical section of a scale of a fossil fish (*Megalichthys Hibberti*), from the carboniferous limestone of Carluke, Lanarkshire. It exhibits three distinct kinds of structure, placed one above the other; the highest presenting a tubular appearance like that of dentine, whilst the lowest is

formed of laminated bone, and the intermediate structure is cancellous like diploë: lacunæ abound in these last-mentioned structures; they are arranged in the direction of the laminæ. The upper layer contains large Haversian canals running from the centre towards the margin of the section, and each sends off from one side only, a series of branching tubuli noticed above, which enter a very thin ganoid layer. This section corresponds in structure with that of transverse sections of the spine of the Sting-ray, and the teeth of many of the cartilaginous fishes.

B a 291. A horizontal section of the same Scale, exhibiting on two of its sides small portions of the outer layer, which may be known by a coarse hexagonal structure; each hexagon has an Haversian canal in its centre, with branching tubuli radiating from it, being a disposition of canals and tubuli common to the teeth of many cartilaginous fishes. The centre of the section presents a cancellated appearance, and the lacunæ are very numerous: they are of elongated figure, and occur between the laminæ.

B a 292. A vertical section of a portion of two scales of a *Megalichthys*, one being shorter than the other: each presents the same characters in all parts, with the exception of the upper edge; in the short specimen the edge exhibits elongated lacunæ arranged in several planes, which cross each other nearly at right angles; these are the peculiar lacunæ represented at *a* in Plate V. fig. 13: they differ very much in shape from those found in any other part of the specimen, and measure on an average $\frac{1}{300}$th of an inch in length. The long specimen has the upper edge of a different character; the section seems to have been made through that part of the scale which exhibits the hexagonal structure, shown at *a* in Plate VI. fig. 11, Haversian canals being present with radiating canaliculi proceeding from them. In this section the lower edge is well displayed; canals may be seen entering it, and the bony matter is arranged in parallel laminæ: all the intermediate structure in both sections exhibits large canals divided transversely with lacunæ of much smaller size and of more circular figure than those on the edges.

B a 293. An oblique section of the same Scale, in which two kinds of structure are visible; one like that seen in the centre of the vertical sections, the other the coarse hexagonal network represented at *a* in Plate VI. fig. 11, each hexagon having a central canal from which branching canaliculi radiate: this preparation is well represented by fig. 11, although it is not the specimen from which the drawing was made.

B a 294. A horizontal section of a scale of a *Megalichthys*, in which four kinds of structure are distinctly seen: commencing with the thinnest edge, a series of circular apertures will be observed: these are Haversian canals divided transversely; the bony matter around them is transparent, and the terminations of the canaliculi are well seen. A little further in advance the hexagonal structure is apparent, and in the centre of each hexagon is a canal giving off a series of branching canaliculi; a little further in advance still, the canals are larger, and in the laminæ of bone surrounding them are numerous lacunæ, most of which have been divided transversely: this structure is succeeded by bony matter without any canals, but in which the peculiar elongated lacunæ, before spoken of, are arranged in several planes, and principally at right angles to each other: they measure on an average $\frac{1}{400}$th of an inch in length.

B a 295. A portion of the surface of a scale of a *Megalichthys*, exhibiting parallel rows of Haversian canals, from each of which branching canaliculi proceed; each branch terminates in bifurcations, giving rise to the peculiar dark markings seen upon all parts of the surface of the bone. The Haversian canals have a broad black line or streak extending from one to the other, so that a series of squares or rhombohedrons are mapped out; these are certainly cracks, and have nothing to do with the structure.

B a 296. A horizontal section of a scale of a *Megalichthys*, in which may be seen a large number of parallel markings occurring in two planes, those in the more superficial being either at right angles or at angles of 45° with those of the plane beneath. The spaces between these markings are

always more or less granular, and the markings themselves are, in some places, of variable breadth; they very strongly resemble the ordinary lacunæ of bone. Some parts of the section have been ground so thin, that all traces of markings or pseudo-lacunæ have been erased.

B a 297. An oblique section of the scale of a species of *Lepidotus*, from the green sand in the neighbourhood of Guildford; it exhibits to the naked eye two kinds of structure, a transparent and an opaque part, as well as a series of undulating laminæ which probably indicate successive stages of growth. All the dark portions present long parallel canaliculi, precisely like those of dentine; they correspond to the lepadine tubes in the *Lepidosteus*. The transparent portions, on the contrary, exhibit lacunæ, and the laminæ are crossed by large branching tubes, similar to those in the *Lepidosteus*, represented in Plate VI. fig. 17. Some parts of the section would tend to prove that the lepadine tubes are given off from lacunæ.

B a 298. A corresponding section of another scale of the same fish, but much more transparent than the last: the lepadine tubes and lacunæ are distinctly shown, but most of the larger tubes are divided transversely: many parts of the upper surface of the section exhibit a granular structure, indicating the presence of a ganoid layer.

B a 299. A vertical section of a scale of the same fish, exhibiting all the structures described in the two preceding specimens. The dark part in the centre shows a series of laminæ, probably lines of growth, which are traversed at right angles by the lepadine tubes and by the larger branching tubes; the transparent parts on the sides of the section, especially those nearest the number, exhibit lacunæ and large tubes only.

B a 300. A vertical section of the bony exo-skeleton of a fish of the genus *Coccosteus*, from the old red sandstone in the neighbourhood of Edinburgh. The bone, which is about the $\frac{1}{12}$th of an inch in thickness, and of a deep brown tint, is traversed by large canals, with numerous lacunæ divided in the direction of their short diameter; that part of the

bone forming the inner or attached surface of the skeleton is much more compact than the outer one.

B a 301. A vertical section of the exo-skeleton of the same *Coccosteus*, in which the Haversian canals are much smaller than in the preceding one. The outer and inner surfaces of the bone are both entire, and will be seen to differ from the other parts of the section in having no canals passing through them. This specimen very much resembles that of a section of a cranial bone in the human subject.

B a 302. A transverse section of the same bone, which is remarkable for the small number of the lacunæ exhibited by a surface more than half an inch square. The lacunæ are of small size, measuring $\frac{1}{2500}$th of an inch in their long diameter : they are arranged in planes, and are best seen where the bone is thickest.

e. *Exo-skeleton in the form of dermal teeth.*

B a 303. A portion of the skin from the anterior surface of the pectoral fin of a spotted Dog-fish, *Scyllium canicula* ; it is covered with a series of tooth-like scales of a tricuspid form, in the interior of which, numerous branching tubuli may be observed proceeding from a central canal or pulp-cavity : small black spots occur at certain regular distances ; these are produced by pigment-cells collected together in groups upon the skin at the bases of the scales.

B a 304. A portion of the skin taken from the posterior surface of the pectoral fin of the same *Dog fish*. The scales are larger than those from the anterior surface, and have only one pointed extremity ; they are also much flatter, and the distribution of the tubuli can be more plainly observed.

B a 305. A portion of the skin covering the saw of a Saw-fish, *Pristis antiquorum* ; it consists of a series of rounded scales, exhibiting a pulp-cavity, from which branching tubuli are given off. The margin of each scale is much thickened, and when mounted in Canada balsam, presents

a granular appearance. A preparation similar to this has already been described, and represented in Plate III. fig. 11.

B a 306. A vertical section of the skin of the same *Saw-fish*, having its free surface covered with a layer of bony teeth in the shape of flattened scales, each exhibiting a dark central cavity, from which branching canals radiate: the scales are somewhat like an hour-glass in shape, and when divided vertically, as seen in this preparation, a cavity, like that shown at *a a* in Plate III. fig. 17, is left between them.

B a 307. A vertical section of a conical spine from the skin of a large species of *Ray*. At the base may be seen Haversian canals divided vertically, each of which gives off canaliculi: on the margins and towards the apex the canals are larger, and from one side only elongated branching canaliculi like the tubes of dentine arise. The apex of the section is coated with a brown layer resembling ganoin; it is traversed by the canaliculi.

B a 308. A transverse section of the base of the same Spine, which in shape somewhat resembles a Maltese cross; it exhibits numerous Haversian canals divided transversely, each of which gives off branching canaliculi; these are so abundant on the margins of the section as to render them quite opaque. On a careful examination of the extremities of some of the canaliculi, they will be found to terminate in lacunæ.

B a 309. A transverse section of the apex of the same Spine, exhibiting a small central cavity from which branching canaliculi radiate to the margin. The brown ganoid layer is present, and displays a minutely striated appearance, probably due to the presence of canaliculi, but those occurring in the central portion of the section cannot be traced into this layer.

B a 310. A transverse section of a small flattened Spine from the same fish, being one of those covering the greater part of the skin. The section is taken from the base of the spine, and consists of two portions, one almost entirely surrounded by the brown ganoid layer before described, the other broad and expanded, forming the base. Both exhibit Haversian canals, which give off numerous canaliculi, those near the ganoid layer being the

largest, and most like the tubes of dentine; the striated appearance is present in the latter structure, and the canaliculi from the central portion can, in this specimen, be distinctly traced into it.

B a 311. A transverse section of the same Spine, taken from near the apex; it is wholly surrounded by the brown ganoid layer, and the canaliculi, which appear to be given off from a central cavity, may be distinctly traced into every part of it.

B a 312. A vertical section of the same Spine, exhibiting similar appearances to those of the vertical section of the larger spine. The base is supplied with very numerous branching canaliculi, like the tubes of dentine; towards the apex, Haversian canals are seen; these give off parallel canaliculi, which can be distinctly traced into the brown ganoid layer.

B a 313. A transverse section of a broad flat spine, situated on the abdominal surface of the same *Ray*; it exhibits in the centre large canaliculi divided transversely, and of the same nature as those described as existing at the base of the small spine, B a 308. Towards the margin are Haversian canals which give off canaliculi; some of the latter may be noticed to communicate with minute lacunæ.

B a 314. A transverse section of one of the same abdominal Spines, exhibiting Haversian canals running towards the circumference, and from which branching canaliculi proceed; these for the most part communicate with lacunæ.

The skin from which the eight preceding preparations were taken, was nearly a quarter of an inch thick, and completely covered on its dorsal surface with two kinds of spiny scales: one short and thick, on an average one-eighth of an inch in diameter, is firmly imbedded by a broad base in the tough horny skin; the other has a broad base spreading into four indented arms like those of a Maltese cross, and in each of the four angles one of the smaller spines is implanted. The base supports a tapering spine, measuring half an inch in length, and having its upper third surmounted by a layer of ganoin. On either side of the skin are other spines having broad bases, but without the intermixture

of smaller ones: these are good representatives of the *placoid* form of scale. There are many fishes of the Ray tribe, having the dorsal surface of their skin covered with numerous small, round, flattened, tooth-like scales, which form the substance known in commerce as Shagreen.

B a 315. A transverse and a longitudinal section of one of the osseous plates of a *Sturgeon*: the first will be found uppermost when the section is held with the name in the right hand: when viewed with the naked eye, a layer darker than the rest will be seen running across it; this consists of a number of large canals transversely divided, around which are arranged numerous lacunæ and smaller canals, with granular matter between them: all the other parts of this section are thin and laminated, with the characteristic lacunæ occurring between the laminæ. The lower or longitudinal section exhibits large canals variously divided, with lacunæ scattered irregularly over the surface; these vary in form, but most of them are of the usual quadrate figure.

B a 316. A vertical section of a bony plate of another *Sturgeon*, in which are seen the same appearances as those previously described. All the parts which seem dark to the naked eye, have the lacunæ in great abundance, with much granular matter between them. The upper margin of this section is convex, and on the edge nearest the name, there is a distinct indication of cellular structure, the cells being as clearly visible as those of common adipose tissue when dried.

B a 317. A horizontal section of the same bony plate, in which the opaque parts noticed in the two preceding preparations are in the form of a series of curves. When carefully examined, this opacity will be found to be in a great measure due to numerous sets of canaliculi proceeding in parallel lines, like the tubes of dentine. In all other parts of the section a laminated condition of the bony matter is very evident, and the lacunæ are of the form peculiar to fishes.

B a 318. A horizontal section of a portion of the same Scale, reduced sufficiently

thin to cause the opacities described in the preceding section to disappear. The lacunæ are extremely numerous, and of the usual quadrate figure; but the dense collections of canaliculi noticed in the last preparation are no longer to be seen.

B a 319. A horizontal section of another scale of the *Sturgeon*, mounted in Canada balsam; numerous Haversian canals are seen divided transversely, and around each canal the bony matter is disposed in laminæ, having lacunæ between them. The outer surface of this section is uppermost, and in all the indentations large pigment-cells are visible.

B a 320. A portion of the bony framework of the rostrum of a Paddle-fish *Planirostra*, which exhibits a great number of lacunæ, resembling those of the *Lepidosteus* and *Fistularia*, in having the central portion or body of the cell very large as compared with the canaliculi.

B a 321. A transverse section of a rounded nodule of bone, probably a spine, from the skin of a fossil fish of the genus *Rhizodus*; it consists of a series of concentric laminæ, which no doubt indicate successive stages of its growth: lacunæ, lepadine tubes, and the large tubes common to the teeth of bony fishes, are present. In the centre of the section, which is ground very thin, the elongated lacunæ peculiar to the bone of this fish, and represented in Plate V. figs. 16 and 17, may be observed.

f. *Exo-skeleton in the form of elongated Spines.*

B a 322. Four transverse sections of one of the dermal spines of a Globe-fish, *Diodon*, one of which is nearly of circular figure, the others being more or less trilobed. They all exhibit traces of a central cavity, around which are numerous minute concentric markings; these are traversed by radiating ones of rather larger size and more apparent, but still they are smaller than the tubuli of dentine, which in other respects they very much resemble. A few broad, dark concentric lines are also seen in two of the sections; these are probably lines of growth, and in the circular

section there are traces of radiating canaliculi. The general structure of these spines is like that represented in Plate VII. fig. 4.

B a 323. Two vertical sections of spines of the same *Globe-fish*, both of which exhibit traces of a central cavity and of canaliculi proceeding from it; all the remaining portions of the spines are composed of transparent bony matter, exhibiting a longitudinally striated appearance, the striæ being best seen at the base of each section.

B a 324. Five transverse sections of a dermal spine of another Globe-fish, *Tetrodon*, each of which exhibits both a radiated and a concentric laminated structure, the former being by far the most marked. These sections correspond in their minute structural peculiarities with those of Preparation B a 322. One of the sections is represented at *a*, in Plate VII. fig. 4; and a segment magnified 100 diameters at *b* in the same figure; the dark concentric lines there displayed indicate the successive stages of growth.

B a 325. A transverse section of a dermal spine of a Skate, *Raia Batis*, exhibiting a large central cavity, from which, branching tubuli radiate towards a very thin ganoid layer forming the circumference. A dark margin is seen midway between the central canal and the circumference, indicating probably the line of growth.

B a 326. A vertical section of the same Spine, in which the course of the tubuli radiating from the margin towards the circumference is seen. The spine is recurved, and near the apex the central cavity is divided, and its margins will be found to present a granular appearance, due to the orifices of the tubuli which commence at this part. There is a tolerably thick ganoid layer near the apex, but no distinct structure is visible in it.

B a 327. A transverse section of one of the dermal spines of a Thornback, *Raia clavata*; it is of circular figure, and exhibits a central cavity from which numerous branching canaliculi radiate to the circumference. There are a few indications of a laminated arrangement; these, however, are best seen near the central cavity.

B a 328. A vertical section of a dermal spine of the same *Thornback*, which is composed of transparent bone supplied with branching canaliculi; these are largest in the centre, and become smaller and smaller as they approach the margin, showing that they were given off from a central cavity.

g. *Appendages to the exo-skeleton in the form of Spines developed in connexion with the Fins.*

B a 329. Two transverse sections of the largest pectoral fin-ray of a Gurnard, *Trigla lyra*. Both are composed of a central opaque granular osseous portion arranged in the form of laminæ, around which there is a zone of transparent bone. In the centre there is an oval cavity or canal, from which numerous canaliculi radiate; these, however, do not appear to extend beyond the opaque portion of the spine above noticed.

B a 330. Three vertical sections of the same Fin-ray, which present to the naked eye three distinct kinds of structure:—1st, a central portion which is opaque; 2nd, a transparent part exterior to it; and 3rd, a series of opaque lines or markings traversing the sections obliquely at nearly equal distances of $\frac{1}{12}$th of an inch. The opaque part in the centre of the section is composed of dark granular bone having numerous canaliculi traversing it obliquely; the transparent exterior exhibits only a faintly fibrous appearance, as though it were made up of ossified fibrous tissue, whilst the striæ or markings, above alluded to, are so opaque as to exhibit only a granular appearance: they are nearly all of the same shape, narrow in the middle and broad at either extremity, and appear as if they had at one time been joints, which in process of growth have become imperfectly ossified.

B a 331. A vertical section of one of the dorsal spines of a Perch, *Perca fluviatilis*. In the central portion, traces of a canal are visible, being in the form of a series of irregular cavities, connected together by a narrow neck, and each sending off a large straight branch towards a dark line, which at one time was the inner margin of the spine, but is now partly coated over by a new bony growth, so that the canals have but a short

space to traverse. The bony matter between the canals exhibits canaliculi and laminæ, but no lacunæ.

B a 332. Two vertical sections of an opercular spine of the Lesser Weaver-fish, *Trachinus vipera* ; each consists of transparent structureless bony matter, exhibiting numerous laminæ, which indicate the successive stages of growth. At the base of both specimens there is a trace of a vascular pulp, and the bone in the neighbourhood is supplied with canaliculi, but no lacunæ are present.

B a 333. A transverse section of a dorsal spine from a large Carp, *Cyprinus carpio*, taken near the base ; it consists of a series of laminæ arranged in a circular form around a central cavity ; between the laminæ are numerous lacunæ, the canaliculi of which are so numerous in some situations, as nearly to render the laminæ opaque.

B a 334. A vertical section of the same spine, one edge of which is serrated, and each of the serrations has a series of curved laminæ around it. In all other parts of the spine, lacunæ are present, and these are arranged in parallel rows ; but where the laminæ are curved, the lacunæ follow the order of the curvatures. A few large Haversian canals are divided transversely, but there is no laminated arrangement of bony matter around them.

B a 335. A transverse section of a dorsal spine of a fish of the genus *Silurus*, exhibiting a central canal, with which large tubes or Haversian canals communicate ; these, after proceeding a short distance towards the circumference, give off an innumerable series of minute canaliculi. Around the canal the bony matter is deposited in concentric laminæ, between which exceedingly long and thin lacunæ are situated ; from these, radiating canaliculi, very much resembling the tubes of dentine, are derived, and their radiating order is only interrupted at those points where the large canals communicate with them.

B a 336. A longitudinal section of a spine of the same *Silurus*, which in small

patches exhibits lacunæ of the normal figure; in others nothing but canaliculi and the divided areas of large canals are visible, whilst in the remaining parts canaliculi are seen transversely divided.

B a 337. A horizontal section of a larger spine of a species of *Silurus*, having a central cavity like the last specimen: two kinds of structure may be observed; one, which forms almost the whole of the section, consists of Haversian canals and elongated lacunæ arranged concentrically; the other, which is situated on that edge of the section nearest the number, and is of triangular figure, exhibits numerous large canals divided transversely, around each of which is a laminated arrangement of bony matter, with so many canaliculi as almost to obscure the elongated lacunæ from which they arise. The spaces between the laminæ of the different concentric systems are occupied by small canals, with very few lacunæ connected with them.

B a 338. A vertical section of another spine of a *Silurus*, in which the Haversian canals are arranged in the form of a network, precisely similar to that existing in the scale of the Hassar-fish: the remaining portion of the section exhibits longitudinal markings, which correspond to the laminæ described in the transverse section; between them are seen the elongated lacunæ, giving off their numerous canaliculi in parallel lines. The body of each lacuna is so small, compared with the canaliculi, that it appears only as a dark line between the laminæ.

B a 339. A horizontal section of the upper surface of a large plate of bone or scale, with which the spine of the *Silurus* is articulated: the free surface of the scale was indented, and to this circumstance are owing the large holes seen in the section. The mouths of numerous canals are visible upon the upper surface, and around each there is a concentric arrangement of lacunæ without any apparent laminæ; the holes before mentioned are encircled, however, by laminæ, between which are lacunæ precisely similar to those described in the transverse section of the spine. The minute granular structure visible in various parts of the section is due to canaliculi divided transversely.

B a 340. A horizontal section from the under surface of the same plate; it consists of dense bone, through which a few Haversian canals pass without having any laminæ disposed around them: the lacunæ, which are of the usual figure, occur in all parts of the section, but the canaliculi are proportionally fewer in number and more branched than on the upper surface of the scale, and are not disposed in parallel lines. This section corresponds precisely in character with the inferior layer of the scales of the Hassar-fish and *Lepidosteus*: the principal points of distinction between this layer and the upper one consist in its containing fewer Haversian canals, which are also without laminæ, and in the lacunæ being of quadrate form.

B a 341. A vertical section of the same plate of the *Silurus*, in which three varieties of bone are readily distinguishable by the naked eye. The first variety is irregular in its outline, and corresponds with the upper free surface of the plate; it consists of dense bone, very like the enamel of a tooth, and may be termed the *ganoid* layer, being composed of a series of well-marked laminæ, between which are lacunæ giving off numerous parallel canaliculi, disposed in a precisely similar manner to those described in the horizontal section of this same layer, and much resembling the tubuli of dentine. No Haversian canals are seen to traverse this layer in a vertical direction, but it will be remarked that wherever the laminæ are wanting, there lacunæ of the usual quadrate form occur. The second variety of bone structure forms the main thickness of the section, and is diploic in its appearance, being traversed by large canals, around each of which a few laminæ are disposed; the lacunæ are likewise scarce, and have evidently been divided transversely. The third kind of bone is very thin, and represents the inferior or attached surface of the plate; it is laminated in character like the upper or free surface; the lacunæ are, however, fewer in number, and the canaliculi still more so.

B a 342. A transverse section of a spine of a *Silurus*, taken from near the base. To the naked eye it exhibits a large central cavity, around which the bony matter is arranged in a series of fine undulating laminæ. When

examined microscopically, a still finer series of laminæ are visible, between which are elongated lacunæ giving off canaliculi at right angles; so numerous and parallel are they, that they resemble the tubuli of dentine. Every here and there Haversian canals are present: they are disposed in a radiated manner; but, although they commence on the inner or pulp-cavity of the section, and run towards the circumference, they do not do so in one plane; on this account, no canal can be distinctly traced from one margin to the other. This preparation is represented of its natural size at *a* in Plate VII. fig. 9; the Haversian canals, as there indicated, are principally confined to the part marked *a*, this being the posterior portion of the spine. Under a power of 15 diameters, as shown in fig. 9, the laminæ and the radiated disposition of the canaliculi are well seen.

B a 343. A vertical section of a portion of the same Spine, which to the unassisted eye exhibits two distinct kinds of structure, one having the laminæ disposed in a series of straight lines, the other in which they are undulating and traversed obliquely by Haversian canals. When examined with a power of 15 diameters, as shown in Plate VII. fig. 10, the laminæ are well seen, and between them are numerous elongated lacunæ, from which the radiated canaliculi before described are given off.

B a 344. A segment of a transverse section of a pectoral spine of a *Silurus*; one margin presents a semicircular indentation; this formed part of the central cavity of the spine; branching canals pass from it towards the interior of the section and anastomose with others which enter from the external surface. All parts of the bony matter are made up of laminæ, and lacunæ, of characteristic shape and abounding in canaliculi, are situated between them.

B a 345. A longitudinal section of a portion of the same Spine, exhibiting five large tooth-like processes projecting from one of its sides; the opposite side is straight, and exhibits canals, which run towards the centre of each tooth. At their commencement the canals give off numerous branches, and the bony matter in their neighbourhood is disposed in concentric

laminæ, but in all parts of the teeth the laminæ are arranged in a series of cones, corresponding with the shape of the tooth: elongated lacunæ with canaliculi arising principally from two opposite sides accompany them.

B a 346. A vertical section of the coracoid bone of the same *Silurus*, to which the spine above described was articulated; it exhibits numerous large canals divided transversely, some having a few concentric laminæ around them; in all other parts of the section laminæ are found crossed at right angles by canaliculi and by lepadine tubes.

B a 347. A vertical section of another portion of the same coracoid bone, consisting of an outer and inner table, with an intervening portion or diploë. All parts are traversed by Haversian canals and by the branching canaliculi of numerous lacunæ.

B a 348. A horizontal section of the same spine, exhibiting to the naked eye a series of markings, some of which are transparent, others opaque; the former are all more or less traversed by branching canals, whilst the latter are rendered opaque by an abundance of canaliculi.

B a 349. A transverse section of a dorsal spine of a fish of the genus *Balistes*; it is composed of very firm transparent bone traversed by large branching canals arising from a cavity in the centre. The anterior surface of the spine is convex, the posterior grooved; the free surface is covered with tooth-like projections; these exhibit a laminated condition of the bony matter, and are separated from each other by branching canals.

B a 350. A horizontal section of the same Spine, which is remarkable for the peculiar arrangement of the large canals: they run principally in parallel lines, and give off communicating branches on either side, so as to form a coarse network with square meshes. In the centre of the section is a spot more opaque than the rest, and in it may be observed the peculiar granular structure described as existing in the bones of the Pike tribe, an appearance produced by transverse section of the large canals. On

one edge of the specimen the tooth-like projections alluded to in the transverse section are plainly seen.

B a 351. A transverse section of a ventral spine of the same *Balistes*; like the preceding specimen it is composed of very transparent bone, which is traversed in various directions by large branching canals. In the centre of the section is a cavity of oval figure, from which parallel tubes are given off; these are of uniform size, but do not extend to the margin: it would appear that they alter their course by suddenly turning at right angles, since in this part they seem to have been divided transversely.

B a 352. A vertical section of the same Spine, one edge of which is serrated. Large parallel canals extend from the centre towards three of the four sides, the remaining one being supplied with branching canals. The spine itself is composed of joints, and two of these are exhibited in the section: the parallel tubes reach as far as these joints, but no further: the bony structure between the joints is clear and transparent, and possesses no trace of canals.

B a 353. A horizontal section of a dorsal spine of the Hassar-fish (*Callichthys*), exhibiting a large central cavity, around which are a series of nearly equidistant laminæ arranged in an undulating manner and traversed by radiating Haversian canals: each of these laminæ presents a granular appearance and a slight radiated arrangement, due to the presence of lacunæ; in one part of the section the laminæ are not very distinct; here, however, are lacunæ of the usual ichthyic character. This preparation is represented of its natural size in Plate VII. fig. 1 *a*, and as seen under a power of 25 diameters in fig. 1; the part exhibiting the lacunæ is shown under a power of 100 diameters in fig. 3.

B a 354. A vertical section of the same dorsal spine, in which the central canal is divided in the direction of its length; it is remarkable for the peculiar distribution of its branches, which are all of large size and frequently bifurcated. The bony matter is disposed in parallel laminæ, and a few

lacunæ can every here and there be distinguished between them. A portion of this preparation, as seen under a power of 25 diameters, is represented in Plate VII. fig. 2.

B a 355. A transverse section of a pectoral spine of a Hassar-fish, exhibiting a central cavity and numerous Haversian canals; the latter are arranged in two principal directions, one in the form of radii in the plane of the section, the other at right angles to it; these last have a few laminæ of bony matter around them. The radiated canals extend in some instances from the central cavity to the circumference, and traverse at right angles a series of laminæ which surround the entire spine, and have canaliculi between them; some of these laminæ are beautifully festooned, and at the spot where the canals cross them, numerous canaliculi are very evident. In some parts of the section there are but few canals; in these spots lacunæ of the usual figure may be observed.

B a 356. Two transverse sections of a dorsal spine of a fossil-fish, *Asteracanthus ornatissimus*, exhibiting numerous Haversian canals of nearly equal size; the bone surrounding them is of a rich brown colour and largely supplied with canaliculi, except the ring forming their immediate walls; in this portion of the bone the structure is lighter and more transparent.

B a 357. A vertical section of the same Spine, which displays two varieties of bone; in the one the Haversian canals are divided almost longitudinally, in the other they are cut more or less transversely; the canaliculi spreading from both sets of canals are well seen, but no lacunæ are present.

B a 358. A transverse section of the dorsal spine of a Fish from the Oolite of Stonesfield; it has a large central cavity, around which the bony material is disposed in a series of undulating laminæ: these laminæ do not extend as far as the circumference of the spine, but on two of the sides, which may be said to correspond with the anterior and posterior surfaces of the spine, there are numerous Haversian canals, more or less obliquely divided. The laminated bone is furnished with numerous branching canaliculi, which pass outwards from the central cavity and

terminate where the coarser vascular structure commences. Man canaliculi are given off from the walls of the Haversian canals, but they do not anastomose with the former set. This preparation is represented of its natural size in Plate VII. fig. 11 *a*; and a portion of the same, magnified 15 diameters, at *b*; the internal laminated structure is shown at *c*, and the part supplied with Haversian canals at *d*.

*Presented by W. R. Binfield, Esq., F.G.S.*

B a 359. A vertical section of the same spine, exhibiting large Haversian canals divided transversely in the centre of the section, but longitudinally on the margin. The bony matter is very transparent and traversed by branching canaliculi, which do not appear to be connected with the Haversian canals: no lacunæ are present either in this or in the transverse section. This specimen, magnified 15 diameters, is represented in Plate VII. fig. 12.

B a 360. A transverse section of a dorsal spine of a Polypterus, *P. niloticus*; it is provided with a central cavity, from which large canals radiate towards the circumference, others of nearly equal size proceed from the circumference towards the centre; all the latter give off branching canaliculi: on one edge of the section, which corresponds to the anterior surface of the spine, a layer of *ganoin* may be observed. This preparation, magnified 25 diameters, is represented in Plate VII. fig. 7, and the ganoid layer is shown at *aa*.

B a 361. A vertical section of the same spine, exhibiting large branching canals divided in various directions; all of them give off canaliculi. This preparation, magnified 25 diameters, is represented in Plate VII. fig. 8.

B a 362. A transverse section of a dorsal spine of a Chimæra, *Chimæra callorhynchus*; it consists of a thin layer of bone surrounding a large semicircular cavity: the bone exhibits numerous Haversian canals, which have been divided more or less transversely; most of them have their origin in the central cavity, and from their sides fine branching canali-

culi are given off. There are no lacunæ in this section, all the bone being supplied with canaliculi.

B a 363. A vertical section of the same Spine, in which a network of large Haversian canals is seen on one of its margins, the other is notched, and appears to be coated with a ganoid layer. All parts of the section exhibit branching canaliculi, but no lacunæ.

B a 364. A transverse section of a dorsal spine of a Dog-fish, *Spinax acanthias*; it exhibits a large central canal of triangular figure, from which delicate branching canaliculi radiate towards the margin. The spine itself is triangular in form, the basal edge is grooved, and the lateral margins are convex and covered with a transparent layer of ganoin; the bone is provided with large Haversian canals, which in this section are divided more or less transversely; and it will be noticed that where the ganoid layer comes into contact with the true osseous matter of the spine, numerous canaliculi are present.

B a 365. A transverse section of the same Spine taken from about the middle; the central triangular cavity is now much smaller, and the bone more abundant and thicker: the branching of the canaliculi and their origin from the central canal, are both well displayed, but the ganoid layer is not so well marked in this section as in the preceding.

B a 366. A transverse section of the same Spine taken from near the apex: it is represented of the natural size at *a*, and, as seen under a power of 25 diameters, at *b*, in Plate VII. fig. 5. The central canal, which still maintains its three-sided form, is now much reduced in size, and from it the branching canaliculi may be seen to proceed: the ganoid layer is exceedingly thin, whilst the bone internal to it is still provided with Haversian canals, the largest of which are situated towards the basal line of the spine, and shown at *c c*. Around the central canal the bony matter is disposed in laminæ, and at the termination of those canaliculi arising from the central cavity, a dark line is seen, which may be considered as the outline of the first layer of growth: between this and

the margin of the section two other lines occur, which also indicate successive stages of growth, but the canaliculi of each division do not anastomose.

B a 367. A vertical section of the same Spine, exhibiting numerous branching canaliculi, which radiate toward the margins; one of these, being more opaque than the other, contains Haversian canals divided longitudinally; these are the same canals as those divided transversely in the preceding section. The canaliculi in the vicinity are very numerous, and the layer of ganoin which is external to them, is seen to be composed of numerous laminæ. This preparation, magnified 25 diameters, is represented in Plate VII. fig. 6; the canals are well shown at the side marked *a*.

B a 368. A transverse section of a spine from the tail of a Sting-Ray, *Trigon pastinaca*, taken from near the base; the central part exhibits numerous Haversian canals divided transversely, each giving off minute radiating canaliculi, the branches of which are surrounded by a well-defined brown marking, precisely similar to that found in the teeth of *Pristis* and *Myliobates*, but the canaliculi from one canal do not communicate with those in the neighbourhood. A short distance within the margin of the section, there are a series of canals which give off long canaliculi from one side only; these proceed forward in a diverging manner, and most of them terminate in dilatations resembling lacunæ. The margin of the section is formed by a thin layer of ganoin, and the specimen itself corresponds in structure with that of the teeth of the Saw-fish, Barracuda-pike, and many species of Shark.

B a 369. A transverse section of the same Spine taken from near the apex, exhibiting precisely similar appearances to the preceding, with this exception, that the branching canaliculi described in it as found near the margin, occur but in half the circumference of this section. The ganoid layer is much thicker than in the last specimen, and is confined to the anterior half of the spine.

B a 370. A vertical section of the same Spine taken from near the base, exhibiting numerous Haversian canals divided longitudinally, and giving off branching canaliculi from all parts of their circumference; one edge is more opaque than the other, and this alone displays the canaliculi and the ganoid layer.

B a 371. A vertical section of the same Spine taken from near the middle; it has nine recurved hooks on each side, which may be regarded as teeth: the central portion of the section exhibits Haversian canals divided longitudinally, each of which gives off long branching canaliculi as in the preceding section: every one of the tooth-like processes has a large central canal, from which canaliculi proceed in the same manner as the dentinal tubuli from the central cavity of a tooth. The outer convex edge of these little teeth is coated with a thick layer of ganoin, that on the opposite edge being very thin.

### i. *Splanchno-skeleton of Fishes.*

The Splanchno- or Visceral-skeleton of Fishes is represented by certain bones and cartilages supporting the branchiæ, and by what are termed the "sense-capsules," to one of which the shell-like bodies called *Otolites* or ear-bones belong. In some fishes the Otolite consists of chalky material, as in the Skate and Shark; in others it is made up of a series of laminæ of calcareous matter more dense than any fish-bone, and having a specific gravity of 2·828: in colour it is of an opaque white, and its structure more nearly resembles that of the operculum of certain shells than any other substance. In most fishes there is a single Otolite in each ear, as in the Cod and Whiting, in others there are two or even three; in the Cod the Otolite is about $\frac{3}{4}$ of an inch in its long diameter, but the remarkable specimen from which the Preparation B a 379 was taken, and which in all probability belonged to one of the large fishes of the tropical rivers of America, is upwards of 2 inches in length, and in general appearance and density resembles a mass of opal.

B a 372. One of the peculiar branchiostegous filaments of a Paddle-fish, *Planirostra Spatula*; it has a considerable resemblance in shape to a fish-hook,

the hooked extremity being that by which it is fixed to the gill-ray. In its intimate structure it exhibits two sorts of lacunæ, one of elongated form, the other more angular or quadrilateral in shape, and precisely resembling those found in the bony framework of the rostrum of the same fish, and already described in Preparation B a 320.

B a 373. One of the branchiostegous filaments from a Herring, *Clupea harengus*. It is composed of that variety of cartilage known as the membraniform, the cells being of more or less elongated figure, those on the margin having their walls much thickened; there is no trace of bony structure to be seen in any part of the specimen.

B a 374. A horizontal section of an Otolite of the Halibut, *Hippoglossus vulgaris*; it is of an oval figure, and exhibits a small opaque nucleus, around which numerous laminæ are disposed in wavy lines, all of them crossed by radiating striæ, like those of the Cod-fish.

B a 375. A horizontal section of an Otolite of a Whiting, *Gadus merlangus*; like that of the vertical section of the Cod, it appears to have been primarily made up of rounded granules; many of these are still present, and surrounded by an opaque line, which is evidently a fissure. Numerous laminæ are arranged around the granules in a wavy manner, and form the great mass of the section; the striæ are so numerous in the centre of the specimen, as to render this part iridescent.

B a 376. A horizontal section of an Otolite of a Plaice, *Pleuronectes platessa*; it is of nearly circular figure, having an opaque nucleus in the centre, around which numerous undulating laminæ are disposed; the striated character is very evident in all parts of the section.

B a 377. A horizontal section of an Otolite of a Chub, *Leuciscus cephalus*; it is of an elongated oval figure, exhibiting traces of undulating laminæ, but the greater part of them appear to have been destroyed by the osseous matter undergoing a species of crystallization.

B a 378. A horizontal section of an Otolite of a Mackerel, *Scomber scombrus*;

it is of an oval figure, and about $\frac{1}{5}$th of an inch in its long diameter. Like all the preceding preparations, it is made up of laminated osseous matter without traces of canals or lacunæ.

B a 379. A horizontal section of an Otolite of a large fish, probably the *Arapaima gigas* of South America; it consists of a series of laminæ, some of which are much undulated, and the section itself in the centre presents a considerable resemblance to one of Agate, but on the margins a radiated structure is apparent: this part of the section is very similar to that of an operculum of a large *Turbo*. The specimen from which the section was taken was of oval figure, measuring two inches in the long, and an inch and a half in the short diameter; some parts of its convex surface were polished, as if by friction. Two smaller Otolites, also with polished surfaces, evidently belonging to the same fish, are preserved in the Museum with the larger one.

B a 380. A horizontal section of an Otolite of a Cod-fish, *Gadus morrhua*, which to the naked eye has somewhat the appearance of an Agate; when viewed with a magnifying power of 100 diameters, it will be found to be made up of wavy laminæ crossed at right angles by radiating striæ; when the striæ are divided transversely an opaque granular structure is evident.

B a 381. A vertical section of an Otolite of a Cod-fish; its figure is plano-convex, and in the centre may be noticed a row of eight dark granules which have coalesced on two opposite surfaces, and laminæ have been deposited around them, but in consequence of these being broader upon the upper than upon the lower surface, the section is a plano-convex one. The minute structure of the earthy matter is striated in some parts and granulated in others, but no trace of canals or lacunæ is to be met with.

B a 382. A portion of an Otolite of a Cod-fish, which has been macerated in diluted hydrochloric acid; the greater part of the earthy matter has been removed, and the organic basis which retains the original form of the specimen presents a fibrous structure.

B a 383. A horizontal section of a portion of the bony sclerotic of a Sun-fish, *Orthagoriscus mola*, consisting of cancellated osseous matter of a brown colour, but exhibiting no traces of canals or lacunæ.

B a 384. A transverse section of a portion of the bony sclerotic of the eye of a Sword-fish, *Tetrapturus belone*; it is of a brown colour and traversed by large branching canals; in some parts of the specimen a few elongated cells, somewhat resembling lacunæ, may be noticed.

B a 385. A horizontal section of the same bony sclerotic, in which the canals are divided at right angles to those in the preceding specimen; they are of oval figure, and full of a brown pigment; cells somewhat like lacunæ in shape may be observed in most parts of the section.

# Division II.

## HISTOLOGY OF ANIMALS.

### Subseries XV. *Endo-skeleton of Reptiles.*

#### Order Batrachia.

The Class Reptilia is divided into four orders, viz. *Batrachia*, *Ophidia*, *Chelonia* and *Sauria*. The skeleton of these animals is much more solid than that of Fishes, with the exception of certain members of the order *Batrachia* or *Amphibia*, which in their early or tadpole stage of existence, resemble fishes in several minute particulars; thus, for instance, the skeleton is imperfectly ossified, and the vertebral column, existing as a cartilaginous cord, is prolonged backwards and gives support to a large locomotive organ or tail; the heart consists of one auricle and one ventricle, and respiration is carried on by means of gills. The structure of the skeleton of a Batrachian reptile may be well studied in the tadpole of the *Rana paradoxa*, which will be found to be partly osseous and partly cartilaginous, explaining in a great measure the curious anomalies met with in the skeleton of the *Lepidosiren annectens*, an animal forming the connecting link between Fishes and Reptiles. Two species of Lepidosiren are known to naturalists; one termed *L. paradoxa*, discovered by Dr. Natterer in the river Amazon; the other, *L. annectens*, belongs to the African Continent, being found in tributaries of the river Gambia; the former has been described by Dr. Bischoff and Professor Hyrtl, the latter by Professor Owen. So close are the affinities of these animals to fishes, that even to the present day it is an unsettled question to which of the two kingdoms they properly belong. The College possesses no specimen of *L. paradoxa*, but through the liberality of Dr. Andrew Smith and Dr. Daniell,

its collection has lately been enriched by many examples of the African species. Professor Owen, who was the first to describe the *Lepidosiren annectens*, classifies it with the fishes, and in the Osteological Catalogue has placed it in a distinct order, named *Protopterus*; but as the structure of its bone, as well as those portions of its skeleton which do not become ossified, are more closely allied to the corresponding tissues of the Batrachia than to those of any fish yet examined, and as it undoubtedly possesses many characters peculiar to fishes, a subdivision of the order Batrachia has been proposed for it, and that of Ichthyo-Batrachia appears to be most expressive of its peculiar affinities. The cranium of the Lepidosiren is almost wholly composed of a firm bone of greenish colour, somewhat like that of the Gar-pike, *Belone vulgaris*, the exception being, the petrous elements of the temporal bone, which are permanently cartilaginous. The vertebral column consists of a fibrous sheath containing a soft cartilage, or in other words, of a chorda dorsalis, like that of the Sturgeon and Lampreys: this is not marked out into divisions corresponding to the bodies of the vertebræ, but is firmer in the caudal portion, where the hæmal spines commence, than in any other part. The neurapophyses are ossified, as are also the neural spines, the hæmapophyses and the hæmal spines; there are thirty-six pairs of ribs, each of which is also composed of osseous tissue. The legs are rudimentary and represented by four filiform appendages, the anterior or pectoral pair being generally shorter than the ventral; both are supported by a central style composed of about thirty joints, and connected by ball-and-socket articulation, the former to the scapular arch, the latter to a portion of cartilage of cruciform figure, which is the only representative of the pelvis. Four specimens taken from this species of Lepidosiren have been described in the First Volume of the Histological Catalogue; they will be found under the following numbers, viz. A a 10, A g 22, A h 7 and A h 8. All these preparations exhibit characters decidedly reptilian, as the parts of the skeleton presently to be described will also be found to do.

a. *Endo-Skeleton of Ichthyo-batrachia.*

B b 1. A transverse section of the vertebral column of a large Lepidosiren, *L. annectens*; the central portion, or that corresponding to the bodies of the vertebræ, consists of a fibrous sheath $\frac{1}{5}$th of an inch in diameter, and

about $\frac{1}{12}$th in thickness, within which is enclosed a soft cartilaginous material, the sheath with its contents being the homologue of the chorda dorsalis of fishes. Immediately above the chord may be seen the spinal marrow enclosed in its bony canal; the two, small, circular portions of cartilage above this, are neural spines divided obliquely.

B b 2. A thin transverse section of the chorda dorsalis of a smaller *Lepidosiren*; the sheath is composed of glistening fibres arranged principally in a circular direction, amongst them some elongated cartilage-cells may be observed. The enclosed cartilage is made up of large cells, the central ones being of hexagonal figure, whilst those near the margin are elongated and flattened; some of them have become so much altered during growth as to resemble broad flattened fibres with pointed extremities, they may occasionally be isolated from each other, but all of them possess a large well-defined nucleus. On comparing the structure of this cellular cartilage with that of the chorda dorsalis of the cartilaginous fishes, the cells will be found of much greater size. In the fish, the nucleus is only occasionally to be seen, but in all the specimens of Lepidosiren yet examined, its appearance is constant. The cells in the chorda dorsalis of the Tadpole, of the Toad and Frog, most nearly resemble those of this animal in their general character. *Presented by Dr. Daniell.*

B b 3. A transverse section of the vertebral column of the same specimen of *Lepidosiren*, taken near the head. The sheath will be found to be much thinner in proportion to the contents, than in the corresponding section of the larger specimen, the enclosed cartilage is also whiter: the canal for the spinal chord is much larger than the chord itself, and only a small quantity of bone enters into its formation. Above the chord may be seen portions of two neural spines, one of which is partly ossified, and may be distinguished by its green colour.

B b 4. A transverse section of the vertebral column of the same *Lepidosiren*, taken within three inches of the caudal extremity of the animal: in addition to the specimen last described (B b 3), the hæmal canal and hæmal

spines may be observed; the aorta, filled with red injection, is preserved in the canal.

B b 5. A vertical section of the vertebral column of the same *Lepidosiren*, made in the direction of the long axis of the body and taken from near its middle part: it exhibits the thickness of the sheath enclosing the cellular chorda dorsalis, above which may be noticed the spinal cord lying in its canal, and portions of the neural spines projecting from the sides of the latter.

B b 6. A longitudinal section of the sheath of the chorda dorsalis of a large specimen of *Lepidosiren*, taken from near the head: the sheath is much thinner than that of Preparation B b 1, and the gelatinous cartilage has been removed. Four parallel rows of opaque markings may be observed, the two outer are of small size and circular figure, the two inner being larger and oval; all consist of bony matter, the two former being the attached extremities of the ribs, the two latter the expanded bases of the neurapophyses.

B b 7. A transverse section of a neural spine of the same *Lepidosiren*, consisting of a central column of transparent cartilage, surrounded by a ring of true bone. When viewed with a power of 250 diameters, the cartilage is composed of numerous large nucleated cells with well-developed walls, and exhibit little or no trace of becoming ossified where they are in contact with bone: the bone itself is made up of laminæ, and lacunæ may be observed between them.

B b 8. A transverse section of one of the ribs of a *Lepidosiren*; it is composed entirely of bone, and exhibits lacunæ having their short diameters placed in the direction of the section; the lacunæ in the centre are larger than those nearer the circumference.

B b 9. A longitudinal section of the same rib, in which the lacunæ will be found of very great length; they occur in parallel rows, and the canaliculi of adjoining rows freely communicate. The lacunæ on the margins of the

specimen are much longer but not quite so broad as those occurring nearer the centre.

B b 10. A vertical section of the petrous element of the temporal bone of a *Lepidosiren*, being one of the portions of the cranium of this animal which does not become ossified: it consists of a structureless matrix, in which numerous cells are imbedded. The cells are of variable figure, having a large circular nucleus in the centre, sometimes containing nucleoli within it: many of the cells are of a fusiform shape, these also have a large nucleus, but no trace of ossification is to be seen in any part of the section; the cartilage, therefore, may be said to belong to that variety termed permanent.

B b 11. A longitudinal section of one of the bones of the cranium of a *Lepidosiren*, exhibiting numerous lacunæ of rounded figure, and remarkable for the great number and frequent branching of the canaliculi given off from them. The central portion or body of the cell, even when of circular figure, not unfrequently measures $\frac{1}{800}$th of an inch in diameter, $\frac{1}{1000}$th of an inch being a good average size. In the same specimen are lacunæ having the central portion of the cell of oval figure, the long diameter of which not unfrequently exceeds $\frac{1}{400}$th of an inch. There is only a trace of one Haversian canal in any part of the specimen. A portion of this preparation, magnified 95 diameters, is represented in Plate V. fig. 20, and two of the large lacunæ under a power of 440 diameters in fig. 21.

B b 12. A longitudinal section of another cranial bone of the same *Lepidosiren*, in which the lacunæ are for the most part arranged in parallel rows, as shown under a power of 95 diameters in Plate V. fig. 22. All these lacunæ are of elongated figure, some of them measure $\frac{1}{200}$th of an inch in the long diameter by $\frac{1}{1500}$th in the short diameter, but most of the smaller ones average $\frac{1}{250}$th of an inch in the long diameter; two of the latter kind, for the sake of illustration, are represented in fig. 23, as seen under a power of 440 diameters.

B b 13. A transverse section of the lower jaw of a *Lepidosiren*, exhibiting nume-

rous Haversian canals divided in the direction of their short diameters: between them may be seen lacunæ of rounded form, giving off canaliculi, which reach as far as the walls of the Haversian canals. In many parts of the section, the lacunæ are absent, but in these, the canaliculi exist, and the canals appear to perform the office of the body of the cell.

B b 14. A longitudinal section of the same jaw of the *Lepidosiren*, in which the Haversian canals are divided obliquely: the spaces between them are broader than in the preceding specimen, and exhibit lacunæ of very large size and abounding in canaliculi; the canaliculi are so numerous in some parts as to render the section opaque.

In Plate V. are represented the lacunæ of certain fossil fishes which have been found to approach most nearly to those of Reptiles. Some of the lacunæ especially, as shown in figs. 10 and 11, are longer than those of the Lepidosiren, but when transversely divided, as exemplified by comparing figs. 6 and 20 together, their short diameters will be found to differ considerably: the nearest approach made by the lacunæ of any fish to those of the Lepidosiren, belong to a fossil species described in Preparation B a 225, but even these have many strong points of difference, as may be seen by comparing figures 17 and 19 with 21 and 23.

b. *Endo-skeleton of Perennibranchiate Batrachia.*

B b 15. A transverse section of the humerus of a Siren, *Siren lacertina*; it is about $\frac{1}{12}$th of an inch in diameter, and the centre is occupied by a medullary cavity, around which the bone is disposed in broad laminæ, having lacunæ of large size between them: there are no lacunæ very near to the medullary cavity, but in all other parts of the bone they are present in great abundance. No Haversian canals are visible, in fact the entire section closely resembles a single Haversian system, the central canal of which is replaced by a medullary cavity. A section of this specimen, magnified 95 diameters, is represented in Plate VIII. fig. 5, and a few of the lacunæ, as seen under a power of 440 diameters, in fig. 6.

B b 16. A vertical section of the same bone taken from near the proximal extremity. The lacunæ are now seen arranged in parallel rows, and there

are two principal varieties of them; one of elongated figure, the other more or less oval. The canaliculi from both varieties are remarkable for their frequent branchings, and anastomoses with each other; they measure on an average $\frac{1}{260}$th of an inch. A portion of this section, magnified 95 diameters, is represented in Plate VIII. fig. 7; and two of the lacunæ, under a power of 440 diameters, in fig. 8. No trace of an Haversian canal is to be seen in any part of the section.

B b 17. A horizontal section of one of the bones of the cranium of a *Siren*, exhibiting lacunæ of two kinds, elongated and oval, the latter being by far the most abundant. There are no Haversian canals in this specimen, but the canaliculi are so numerous and their anastomoses so complete that the bony matter can scarcely be seen between them.

B b 18. A larger section taken from another bone of the cranium of the same *Siren*, which has been mounted in Canada balsam; the two kinds of lacunæ are present, but the balsam having filled most of the canaliculi, the central portion of each lacuna only is visible.

B b 19. A horizontal section of a portion of the cranium of a Proteus, *Proteus anguinus*, exhibiting lacunæ of large size and rounded figure, and measuring on an average $\frac{1}{800}$th of an inch in diameter, as shown in Plate VIII. fig. 28, under a power of 95 diameters, and magnified 440 diameters in fig. 29. The section is mounted in Canada balsam, and the oval and circular lacunæ visible in most parts of the section have their canaliculi filled with the balsam, while the centre of each is occupied by air.

B b 20. A horizontal section of the upper portion of the cranium of a *Proteus*. The lacunæ are of large size and principally of the circular variety, they are arranged without much order in the most transparent portion of the specimen; no trace of Haversian canals is present, but the canaliculi of the lacunæ frequently anastomose. In some parts the section has been made so thin that the lacunæ appear as holes.

B b 21. A transverse section of the humerus of an Axolotl, *Axolotes marmoratus*; it is about $\frac{1}{20}$th of an inch in diameter, and exhibits a central medullary cavity with twelve distinct bony laminæ around it; the lacunæ are of peculiar figure, having canaliculi both large and numerous, as compared with the size of the body of the cell, which in this case has been divided in the direction of the short diameter. A portion of this preparation, magnified 95 diameters, is represented in Plate VIII. fig. 9, and a few of the lacunæ under a power of 440 diameters in fig. 10.

B b 22. A vertical section of the same bone, exhibiting at one extremity the appearance represented in Plate VIII. fig. 11, but at the opposite, which is much broader, the bone appears to be in process of formation. Large cells of oval or circular figure may be seen arranged in parallel rows between two opaque lines of bony matter, all the intermediate tissue being composed of minute cells, which refract light very strongly as if they contained oily matter. Three of the lacunæ, magnified 440 diameters, are represented in fig. 12.

B b 23. A horizontal section of one of the cranial bones of an *Axolotl*, mounted in Canada balsam; one part of it is transparent, the other opaque, the latter is rendered so by the abundance of lacunæ and canaliculi. In the transparent part, the lacunæ are very abundant and of elongated figure; the minute black dots and lines seen in various parts of the section are portions of canaliculi.

c. *Endo-skeleton of Abranchia.*

B b 24. A transverse section of the radius of a Menopome, *Menopoma Alleghaniense*. It is about $\frac{1}{12}$th of an inch in diameter, the centre being occupied by a medullary cavity with a single Haversian canal in its proximity; there are fourteen concentric laminæ, between which are lacunæ of nearly equal size; their canaliculi are so numerous that the osseous matter can hardly be distinguished. In the neighbourhood of the Haversian canal, a few large rounded lacunæ occur, three of which are represented in Plate VIII. fig. 14, and a portion of the section itself in fig. 13.

B b 25. A vertical section of the proximal extremity of the same bone; it exhibits traces of an Haversian canal running down the centre of the specimen, on either side of this the canaliculi are so numerous as almost to obscure the lacunæ to which they belong. On the edges, the lacunæ are disposed in parallel rows, as represented in Plate VIII. fig. 15. At the upper or broad extremity there is a structure precisely like that described in the corresponding section of the Axolotl, in which, new bone appears to be forming; two of the rounded lacunæ, magnified 440 diameters, are shown in fig. 16.

B b 26. A portion of the cranium of a *Menopome* mounted in Canada balsam; it exhibits two forms of lacunæ, the one elongated and occurring in parallel rows, as shown in fig. 15, the other of oval figure and scattered irregularly throughout the section. A short Haversian canal is to be seen in the transparent portion of the specimen.

B b 27. A horizontal section of another bone of the cranium of the same *Menopome*, in which the lacunæ are exceedingly well displayed; they are of various kinds, the elongated variety being formed by a prolongation, as it were, of the extremities of the oval lacunæ.

B b 28. A transverse section of one of the bones of the fore extremity of a Batrachian Reptile, allied to the Menopome, found in the interior of a fossil tree occurring in the carboniferous limestones of the Joggings coal-mines, Nova Scotia. It exhibits a large oval medullary cavity surrounded by numerous Haversian canals: the lacunæ are of large size, those near the centre of the section being of circular figure and arranged without much order, whilst those on the margin are elongated and disposed in lines parallel to the contour of the margin.

*Presented by Sir Chas. Lyell, F.R.S.*

B b 29. A vertical section of the same bone, in which the canaliculi are so abundant in every part, as almost to obscure the lacunæ; they are also very large in proportion to the size of the lacunæ, and by their frequent

anastomoses a minute hexagonal network is marked out. The lacunæ are of oval figure, and are principally arranged in parallel rows.

B b 30. A series of chippings from another bone of the same Reptile, which have been mounted in Canada balsam : the lacunæ are well seen in most of the specimens, they are of oval figure and measure on an average $\frac{1}{570}$th of an inch in their long diameter.

B b 31. Chippings obtained from a series of vertebræ occurring in the same block of Limestone, which were first supposed to be those of a fish, but microscopic examination shows that they are really Batrachian, and that they probably belong to the same animal as the three preceding preparations.

d. *Endo-skeleton of Caducibranchiate Batrachia.*

B b 32. A longitudinal section of the femur of a Newt, *Triton cristatus*; it exhibits a trace of a medullary cavity and of many large Haversian canals, some of which contain a brown-coloured material, probably blood. Around each of these canals the bone is slightly laminated, but in all the other parts the lacunæ are disposed in parallel rows ; they are rather smaller in size than those in the *Perennibranchiata* before described. The lacunæ in the centre of the section are of rounded form, but those placed near the margin are elongated. A portion of this preparation, magnified 95 diameters, is represented in Plate VIII. fig. 3 ; and three of the lacunæ under a power of 440 diameters in fig. 4.

B b 33. A horizontal section of the cranium of the same *Newt*, in which the lacunæ are nearly all of the rounded form. The thicker portions of the section exhibit Haversian canals divided transversely, and around them laminæ are arranged, in some cases three in number, between each of which, are lacunæ of elongated form. A portion of this preparation, magnified 95 times, is represented in Plate VIII. fig. 1 ; and three of the lacunæ under a power of 440 diameters in fig. 2.

B b 34. A transverse section of the femur of the common Frog, *Rana tempo-*

*raria*, exhibiting a large medullary cavity, around which the bony matter is disposed in three broad layers: the internal layer exhibits lacunæ having their long diameters arranged in the plane of the section; in the two outer layers they are divided transversely. A segment of this section is shown magnified 95 times, in Plate VIII. fig. 20, and a portion of the two inner layers under a power of 440 diameters, in fig. 21.

B b 35. A longitudinal section of the upper part of the femur of the same *Frog*. The broad extremity seems to be made up of two symmetrical portions, which is owing to the large size of the medullary cavity at this part; the remainder of the section is solid, and when magnified 95 times, exhibits the appearance delineated in Plate VIII. fig. 22. On the margins of the section the lacunæ are arranged in parallel rows, but in the centre they cross each other at various angles in no apparent order; between these two parts, viz. the centre and the circumference, the lacunæ are of a rounded form. The lacunæ of the centre are represented, under a power of 440 diameters, in fig. 23; the rounded variety last mentioned, in fig. 24.

B b 36. A horizontal section of one of the bones of the cranium of the same *Frog*, which has been mounted in Canada balsam. The lacunæ are all of elongated figure, and are disposed in parallel rows; no trace of Haversian canals is present.

B b 37. The two scapulæ of a young Frog, mounted in Canada balsam: all the thicker parts near the articular extremity, exhibit elongated lacunæ arranged in parallel rows, whilst in all the thin newly-formed portions, they are of large size and rounded figure, many of them measuring on an average $\frac{1}{1500}$th of an inch in diameter.

B b 38. A transverse section of the tibia of a Bull Frog of America, *Rana boans*; it is $\frac{1}{8}$th of an inch in diameter, and has a large medullary cavity, around which the bony matter is disposed in concentric laminæ, with numerous lacunæ between them; these are arranged principally with their short diameters in the direction of the section, and thus appear of small

size. Three Haversian canals are present in one part of the section, and around each, there is no disposition to a laminated arrangement.

B b 39. A longitudinal section of the femur of the same Bull Frog, in which the lacunæ of the central portion are of rounded form, and measure $\frac{1}{1500}$th of an inch in diameter, whilst those on the margins are elongated and disposed in parallel rows; these last measure on an average $\frac{1}{450}$th of an inch in length. When this section is contrasted with one of the common Frog, as represented in Plate VIII. fig. 22, the principal difference will be found to consist in the absence of the elongated lacunæ of the centre, the place of which is occupied by the rounded lacunæ mentioned above.

B b 40. A transverse section of the bone of a large Reptile, probably *Labyrinthodon*, from the bed of the Avon, at Aust Passage, near Bristol. It exhibits numerous large Haversian canals, around which the bony matter is deposited in a laminated form; the lacunæ between the laminæ are mostly divided transversely, and present a rounded appearance. A portion of this section, including two Haversian canals, is represented in Plate VIII. fig. 25, but the majority of the canals are filled with the sandstone in which the fossil is imbedded. Four of the lacunæ, as seen under a power of 440 diameters, are represented in fig. 26.

*Presented by Dr. Frederic Brittan.*

B b 41. A longitudinal section of the same bone, in which the large Haversian canals are divided principally in the direction of their length: the portions of bone between them are very narrow, and the lacunæ are arranged in parallel rows; many of them measure $\frac{1}{5000}$th of an inch in their long diameter, as shown in Plate VIII. fig. 27. When contrasted with those in corresponding sections of the Frog, in figs. 23 and 24, they will be found to exceed them in size.

B b 42. A longitudinal section of the same bone mounted in Canada balsam. The osseous matter by this process is rendered more transparent, and the lacunæ are seen in great perfection. The bone from which these sections

are taken is in the Museum of the Bristol Institution; it is upwards of two feet in length, and 18 inches in circumference, and is generally considered to be the femur of a large Batrachian, an opinion confirmed by the character of its lacunæ.

*Presented by W. B. Carpenter, M.D., F.R.S.*

B b 43. A transverse section of the tibia of a Toad, *Bufo vulgaris*, exhibiting a large medullary cavity surrounded by a few bony laminæ: numerous Haversian canals are present in various parts of the section, and all of them have a laminated arrangement around them, one in particular, of large size, has eight such laminæ. This preparation, magnified 8 times, is represented at *a*, in Plate VIII. fig. 19; and a segment of the same, showing three Haversian canals, in fig. 17, under a power of 95 diameters. The lacunæ are of large size, as may be seen in fig. 18.

B b 44. A longitudinal section of the proximal extremity of the same bone, in which the medullary cavity can be traced for some considerable distance; the bone is thin and transparent, and both on the outer margin and on each side of the medullary cavity, the lacunæ are arranged in parallel rows: they are of elongated figure, but in the transparent parts are rounded and disposed in no apparent order. Two of the largest lacunæ, under a power of 440 diameters, are represented in Plate VIII. fig. 19. When this section is contrasted with the corresponding one of the Frog, B b 35, the crossing of the elongated lacunæ appears to be altogether wanting.

## Order Ophidia.

B b 45. A transverse section of one of the ribs of a Tiger Boa, *Python tigris*, represented under a power of 8 diameters, in Plate IX. fig. 1: the central portion is occupied by a large irregular medullary cavity, around which the bony matter is disposed in concentric laminæ, except on the broadest side, where the laminated arrangement is disturbed by the presence of an Haversian canal, shown at *a*, and here the laminæ occur, as seen in

fig. 2, when magnified 95 diameters. The lacunæ are principally divided in the direction of their short diameters, and consequently appear of small size, but the canaliculi are exceedingly numerous. In the neighbourhood of the Haversian canal there are a few lacunæ of rounded figure, which are shown under a power of 440 diameters in fig. 3.

B b 46. A longitudinal section of the same rib, exhibiting lacunæ of the elongated form, all of which are arranged in parallel rows, as shown in Plate IX. fig. 4; many of them are of great length, as the examples seen in fig. 5 indicate, when magnified 440 diameters.

B b 47. A longitudinal section of a vertebra of the same *Python*, in which the lacunæ are disposed principally in parallel rows, as in the corresponding section of the rib. One edge of the section is exceedingly thin, and the granular appearance which it presents is owing to divided canaliculi.

B b 48. A horizontal section of one of the parietal cranial bones of the common Snake, *Coluber natrix*. In the centre is seen an opaque spot of quadrangular figure, arising from a collection of large lacunæ, which are provided with but few canaliculi; it seems from its position to be a centre of ossification. The rest of the specimen is very transparent and exhibits lacunæ of two kinds, but they are much smaller than those of the Python, measuring only $\frac{1}{450}$th of an inch in their long diameter.

B b 49. A horizontal section of a similar cranial bone of the Slow-worm, *Anguis fragilis*. The lacunæ are very numerous, and follow the curvature of the margins of the section: in the centre is seen a transparent portion of bone, in which lacunæ of an elongated form are arranged at various angles to each other, as is found in the longitudinal section of the femur of the Frog. Some of these lacunæ measure $\frac{1}{500}$th of an inch in length.

B b 50. A horizontal section of a corresponding bone of an Amphisbæna, *Amphisbæna alba*. The lacunæ are principally of rounded figure, and remarkable for the numerous branchings of the canaliculi, which are so

abundant in some parts, as almost to obscure the lacunæ themselves. The lacunæ measure on an average $\frac{1}{1800}$th of an inch in diameter.

B b 51. A horizontal section of a cranial bone of a Viper, *Coluber Berus*, which in its minute structure resembles in a most striking manner that of the three preceeding specimens. The lacunæ are mostly of oval figure, and measure $\frac{1}{600}$th of an inch in their long diameter; the canaliculi, like those of Reptiles generally, are of large size as compared with that of the central portion of the cell. One Haversian canal is present, and around it the bone is slightly laminated.

## Order Lacertilia.

B b 52. A transverse section of the femur of an Iguana, *Iguana tuberculata*; it exhibits a large medullary cavity and one Haversian canal of considerable size; the section exactly corresponds with that of the rib of the Python, B b 45, in exhibiting concentric laminæ with lacunæ, which have been divided transversely, lying between them. The section itself, magnified 3 diameters, is represented in Plate IX. fig. 10, and a segment of the same, under a power of 95 diameters, in fig. 11; a few of the lacunæ, magnified 440 times, are shown in fig. 12.

B b 53. A longitudinal section of the same bone, in which the lacunæ are arranged in parallel rows; most of them are divided in the direction of their length, and when viewed with a power of 95 diameters, present the appearance shown in Plate IX. fig. 13; two of the most characteristic specimens being represented in fig. 14. In the centre of this section there is a slight indication of the peculiar arrangement found in the corresponding bone of the Frog.

B b 54. A transverse section of the femur of an Iguanodon, *Iguanodon Mantelli*, exhibiting numerous Haversian canals of small size, many of which are divided obliquely. Each canal is surrounded by six or eight laminæ, which are severally accompanied by lacunæ; they are of large size, but few of them present any trace of canaliculi. This preparation,

magnified 95 diameters, is represented in Plate IX. fig. 15, and some of the lacunæ, divided transversely, are shown under a power of 440 diameters in fig. 16. *Presented by Dr. Mantell, F.R.S.*

B b 55. A vertical section of the same bone, exhibiting numerous Haversian canals, most of which are divided in the direction of their long diameters. The lacunæ follow the direction of the canals, and show the canaliculi more plainly than the transverse section. One of the Haversian canals, with its accompanying lacunæ, is represented in Plate IX. fig. 17, under a power of 95 diameters; and a portion of the same section, magnified 440 diameters, in fig. 18. The lacunæ measure on an average $\frac{1}{1200}$th of an inch in diameter.

B b 56. A transverse section of the femur of a Monitor Lizard, *Varanus variegatus*, exhibiting a very irregular arrangement of bony laminæ. A few Haversian canals are present, and each has, on an average, three laminæ around it. In some parts the lacunæ are divided transversely, but in others, either obliquely or longitudinally. A segment of this section is represented in Plate IX. fig. 30, and a few of the lacunæ in fig. 31.

B b 57. Two vertical sections of the femur of the same *Lizard*, both of which exhibit Haversian canals running in parallel lines; the lacunæ instead of following the direction of the canals, are arranged irregularly: they are of peculiar rounded figure, as shown in Plate IX. fig. 32, or, more highly magnified, in fig. 33. The average diameter of some of these lacunæ is $\frac{1}{1300}$th of an inch.

B b 58. A transverse section of the femur of a small Flying Lizard, *Draco volans*, which agrees with that of the Iguana in having a large medullary cavity with laminæ and lacunæ disposed around it. A segment of this section is represented in Plate IX. fig. 19, magnified 95 diameters; the lacunæ, which are of elongated figure, are shown under a power of 440 diameters in fig. 20.

B b 59. A vertical section of the femur of the *Draco volans*, in which there is no trace of a medullary cavity. The lacunæ on the margins of

the section are arranged in parallel rows, and are of elongated figure, as shown at *a*, in Plate IX. fig. 21, under a power of 95 diameters, or, more highly magnified, in fig. 22. In the centre of the section, as shown at *b*, fig. 21, the lacunæ are of rounded figure, and arranged in an irregular manner; a few of them are represented in fig. 23, under a power of 440 diameters.

B b 60. A portion of one of the elongated ribs of the *Draco volans*, which supports the expanded membrane or wing; it is perfectly straight, and its centre is occupied by a large medullary cavity, in the walls of which the lacunæ are disposed in parallel rows.

B b 61. Portions of three of the ribs of the same *Draco volans*, mounted in Canada balsam; they have not been reduced in thickness, and the lacunæ will be seen to surround the medullary cavity on all sides. In this particular, the structure of the rib agrees with that of the Ophidian reptiles.

B b 62. A transverse section of one of the bones of the wing of a *Pterodactyle*, from the lower chalk of Kent. The Haversian canals run in two directions; one, at right angles to the length of the bone, and the other parallel with it. When they run in the direction of the section, the lacunæ in the neighbourhood present their long diameter; but where the canals have been transversely divided, the short diameter of the lacunæ is seen. There is little or no trace of a laminated arrangement around the canals, but the canaliculi, which are very numerous, form a hexagonal network. A portion of this preparation, in which the lacunæ are divided transversely, is represented in Plate IX. fig. 24; the network formed by the canaliculi is better shown, under a power of 440 diameters, in fig. 25. *Presented by J. S. Bowerbank, Esq., F.R.S.*

B b 63. A transverse section of the same bone, in which the canals and lacunæ have been divided more or less obliquely in consequence of the bone itself being much crushed. The greater part of the section exhibits the same appearances as those of the preceding specimen, the lacunæ being divided in the direction of their short diameters; there are, however, two

narrow portions, in which the bone has been cut vertically; in these the long diameter of the lacunæ may be observed.

B b 64. A transverse section of another wing-bone of the same *Pterodactyle*, showing the matrix of chalk in which the bone was imbedded. It exhibits the same characters as the preceding specimen, the lacunæ both in the outer and inner margin of the section being arranged in parallel rows, following the direction of the canals, whilst in the centre they are divided transversely.

B b 65. A vertical section of the same bone as B b 62; it exhibits numerous lacunæ, all of which are arranged in parallel lines; a few traces of Haversian canals are seen, but they are of small size. The lacunæ themselves are very much elongated, being the $\frac{1}{400}$th of an inch long by the $\frac{1}{6000}$th of an inch broad; except in size, they precisely resemble the lacunæ of some of the Sauroid fishes represented in Plate V., and especially those shown at fig. 10.

B b 66. A vertical section of the same bone taken from near the centre. The lacunæ are disposed principally in two planes; those found in one plane being arranged for the most part parallel with each other, but at angles of 95° to those lying in the plane beneath; this peculiar crossing of the lacunæ is confined, in other animals, to a few of the Sauroid fishes, and to the central portion of the long bones of the Frog; but their size differs from that of the present specimen, being larger in the fish and considerably smaller in the Frog, as may be seen by comparing figs. 10 and 11 in Plate V., and figs. 22 and 23 in Plate VIII., with figs. 26 and 28, Plate IX. Two portions of this preparation, as seen under a power of 95 diameters, are represented in Plate IX. figs. 26 and 27, and under a power of 440 diameters, in figs. 28 and 29.

B b 67. A thin fragment of bone from the lower chalk of Kent, supposed to be that of a bird, but which is of the same nature as the one previously described, if not a part of the same animal; it exhibits the peculiar arrange-

ment of the lacunæ noticed in the preceding specimen; many of them are filled with Canada balsam, but in others nuclei may be observed.

B b 68. A series of chippings taken from the same bone, some of which exhibit the lacunæ arranged in parallel rows, others the peculiar crossing described in the two preceding sections.

B b 69. A transverse section of a small tapering bone, probably of *Pterodactyle*, from the Stonesfield slate; it exhibits numerous small Haversian canals, all of which are divided transversely, and appear to be disposed in a series of concentric circles; there is a slight laminated arrangement around each canal, and in one spot, in the centre of the section, there are numerous laminæ arranged concentrically with the margins of the section, and in this part the lacunæ are best seen; they follow the direction of the laminæ, and their canaliculi are so abundant as almost to obscure the lacunæ. *Presented by J. S. Bowerbank, Esq., F.R.S.*

B b 70. A vertical section of the same bone, exhibiting numerous Haversian canals divided in the direction of their length; they measure from the $\frac{1}{1000}$th to $\frac{1}{800}$th of an inch in diameter. The lacunæ are disposed in parallel rows, and vary in length from the $\frac{1}{1000}$th to $\frac{1}{600}$th of an inch, those about $\frac{1}{800}$th being the most common: the short diameter of the same lacunæ is seldom less than $\frac{1}{4000}$th of an inch, some specimens are even as large as $\frac{1}{2000}$th. When the lacunæ in this section are compared with those of the chalk Pterodactyle, they will be found to differ considerably; the same difference is also observable in the transverse sections of the two bones.

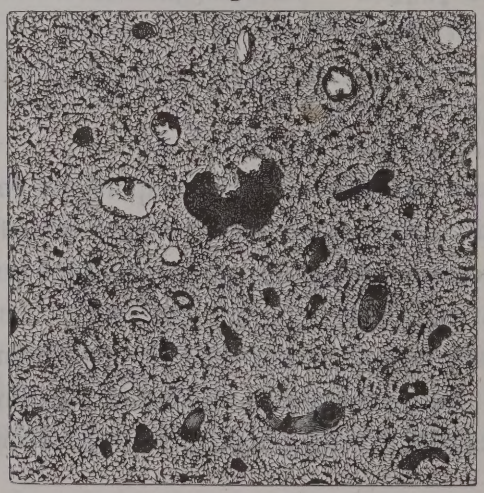
B b 71. A transverse section of a conjoined scapula and coracoid bone of a *Pterodactyle*, from the Stonesfield slate. Two kinds of structure are visible, one firm and compact, forming the outside of the bone, the other cancellated and occurring in the interior; the former exhibits numerous small Haversian canals, around which there is only a faint trace of laminated arrangement; the lacunæ are all divided in the direction of their short diameter, the canaliculi are exceedingly numerous, and by frequent anasto-

moses with each other, an hexagonal network is produced precisely similar to that shown in Plate IX. figs. 24, 25 ; the latter, or cancellated portion of the section, is distinctly laminated, the laminæ following the direction of the canals ; the lacunæ are situated between the laminæ, and the long diameter of each is shown.

B b 72. A vertical section of the same bone, in which the Haversian canals run in parallel lines, the lacunæ accompanying them : they correspond in form and arrangement with those previously described in Preparation B b 70, being both shorter and broader than those of the Pterodactyle of the chalk.

B b 73. A transverse section of a flattened bone of a *Pterodactyle*, from the Stonesfield slate. It exhibits numerous Haversian canals of various sizes, all of which have been divided transversely ; the bone around the larger canals shows slight traces of lamination, but this appearance is not so evident around the smaller ones. The lacunæ are disposed concentrically; they are not very abundant, but their canaliculi are so numerous, and branch so frequently, that they form a minute hexagonal network somewhat like that described in the corresponding section of the Pterodactyle of the chalk. A portion of this section is represented in fig. 1, as seen under a power of 100 diameters ; the laminated condition of the bone is almost wholly obscured by the network formed by the canaliculi.

Fig. 1.



B b 74. A vertical section of the same bone, in which two distinct characters may be observed; in the one shown at *a* in fig. 2, Haversian canals are present, and the lacunæ are disposed in parallel rows; in the other, which immediately joins the first, as seen at *b*, the canals are absent, and the lacunæ are arranged in the peculiar manner before described in the corresponding section of the Pterodactyle of the chalk, B b 66; they are inclined to each other at various angles, and occasionally one may be seen crossing another at right angles. In fig. 3 some of the lacunæ are represented, as seen under a power of 440 diameters: they measure on an average $\frac{1}{700}$th of an inch in the long by $\frac{1}{3000}$th in the short diameter, whilst in fig. 4 some of those of the Pterodactyle of the chalk are given under the same power for the sake of comparison; it will be at once seen that the two differ very considerably.

Fig. 2.

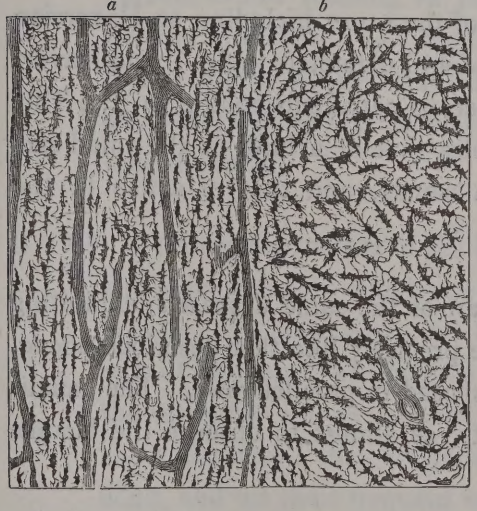



Fig. 3.

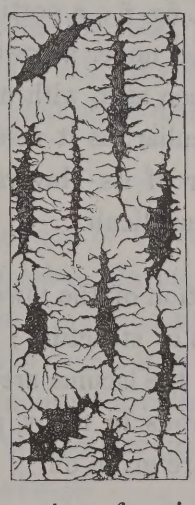
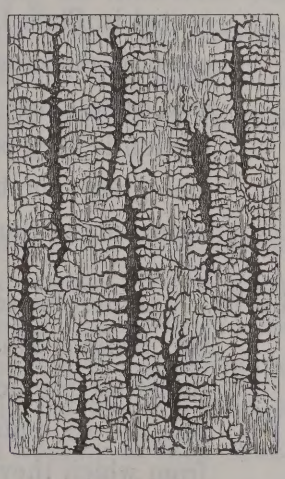


Fig. 4.



B b 75. A transverse and a longitudinal section of a wing-bone of a *Pterodactyle*, said to be from the Wealden formation of Sussex; they are both so nearly allied, in their intimate structure, to the corresponding sections of the same animal from the Stonesfield slate, as to require no further description. The lacunæ in the longitudinal section are particularly well seen.

B b 76. A transverse section of a long bone said to be of a *Pterodactyle*, also from the Wealden; it corresponds precisely in its minute structure with



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that of Preparations B b 71 and 73. The Haversian canals and lacunæ are both divided in a direction at right angles to their length, but there is little or no trace of lamination of the bony matter in any part of the section, except around the circumference. The peculiar branching of the canaliculi is well shown.

### Order Crocodilia.

B b 77. A transverse section of the femur of a Crocodile, *Crocodilus biporcatus*, exhibiting numerous small Haversian canals, around which there is no decided laminated arrangement. The lacunæ are disposed concentrically, and are remarkable for their large size, and the frequent branching of their canaliculi: no lacunæ occur near to the margins of the Haversian canals, but the canaliculi may be distinctly seen to communicate with them. A segment of this section, as seen under a power of 95 diameters, is represented in Plate IX. fig. 6; a portion of the same, including an Haversian canal, is represented under a power of 440 diameters in fig. 7; an Haversian canal being seen at *a*, with numerous canaliculi ending in it. This section is very peculiar, as it resembles that of a bird, in the small size and great number of its Haversian canals, and that of a fish in the branching of the canaliculi.

B b 78. A transverse section of the lower jaw of the same *Crocodile*, exhibiting two distinct kinds of structure; one precisely like that described above, the other in which the lacunæ are disposed in parallel rows. The canaliculi are so numerous in many parts, as almost to obscure the lacunæ from which they are given off.

B b 79. A vertical section of the femur of the same *Crocodile*; in the greater portion of which the Haversian canals are divided in the direction of their length, in other parts the section has traversed them more or less obliquely; the lacunæ are well displayed in both. In the former they are arranged in parallel rows, as shown in Plate IX. fig. 8; some of them are of very great length, as may be seen in fig. 9, magnified 440 diameters.

B b 80. A vertical section of the femur of a *Crocodile*, mounted in Canada balsam. In some parts, lacunæ of the usual shape may be seen, in others, numerous branching tubuli like those of dentine, are apparent; these last appear to be modified canaliculi.

B b 81. A transverse section of the femur of a *Crocodile*, from the Lias of Charmouth, Dorset. Near the outer surface it exhibits the peculiar arrangement of Haversian canals and lacunæ described in the recent section, but nearer the centre the canals are very large, and each is surrounded with a thin layer of bone presenting lacunæ of the ordinary figure. The boundary of each Haversian system is very plainly indicated, being of a darker colour than any other part of the section.

B b 82. A longitudinal section of the same bone, in which are numerous Haversian canals running in parallel lines and giving off transverse connecting branches. The lacunæ, for the most part, follow the direction of the canals, but the canaliculi are not very evident; they measure on an average $\frac{1}{4000}$th of an inch in their short diameter, and $\frac{1}{500}$th in their long diameter.

B b 83. A transverse section of the lower end of the femur of a large Alligator, *Alligator lucius*, in which are numerous Haversian canals divided transversely; the laminæ around them are few in number, and in most cases cannot be seen. The lacunæ are arranged in a concentric manner round the medullary cavity, and are principally divided in the direction of their short diameter; they are remarkable for the great number of their canaliculi, and for their frequent branchings.

B b 84. A longitudinal section of the same bone, which exhibits to the naked eye two different kinds of structure, one very compact, the other more or less cancellated; the former corresponds with the circumference of the bone, the latter with the more central portion. In the compact tissue, the Haversian canals are small in size and few in number, and the lacunæ are arranged in parallel rows; in the cancellated structure, the canals are

larger in size and furnished with concentric laminæ; the lacunæ between them are remarkable for the number of their canaliculi.

Order Enaliosauria.

B b 85. A transverse section of a vertebra of an *Ichthyosaurus*, from the lias. It is entirely composed of cancellated structure, and exhibits numerous lacunæ of the usual reptilian character, but most of the canaliculi have been destroyed.

B b 86. A longitudinal section of a vertebra of the same *Ichthyosaurus*, which, like the transverse one, exhibits a cancellated structure; the lacunæ are very numerous, but all their canaliculi have been destroyed. Many of the lacunæ have a white spot in the centre, which may be considered as the remains of the nucleolus of the original cartilage cell.

B b 87. A transverse section of the lower jaw of an *Ichthyosaurus*, in which Haversian canals are very abundant, and each surrounded with a laminated arrangement of bone. The lacunæ in the neighbourhood of the canals follow the direction of the laminæ, but are not very numerous, although much more so in the spaces between the Haversian systems; the canaliculi are well displayed, and the Haversian systems are connected by what appears to be an elongated lacuna of fusiform shape, as shown in Plate IX. fig. 34, but which in fact should be regarded as a fissure. This preparation, magnified 95 diameters, is represented in fig. 34, the fusiform bodies being there shown; a few of the lacunæ, magnified 440 diameters, are seen in fig. 35.

B b 88. A longitudinal section of the same jaw, exhibiting a parallel arrangement of Haversian canals, and two distinct kinds of lacunæ in the bone structure; those nearest the canals being arranged with their long diameter parallel to the canals, as shown at *a* in Plate IX. fig. 36, whilst an intermediate set, *b*, are much closer together and of rounded figure; both kinds are represented under a power of 440 diameters in fig. 37. The length of the first kind is $\frac{1}{800}$th, of the second the diameter varies from $\frac{1}{2000}$th to $\frac{1}{1000}$th of an inch.

B b 89. A vertical section of a portion of a Paddle of an *Ichthyosaurus*; it consists of a series of bones of nearly cubical figure, the centre of each of which is of a brown colour, and the margin more or less transparent; the former exhibits lacunæ of precisely the same character as those of the other bones of the same animal, but the latter is minutely cancellated, the cancelli being nearly all of the same size; in the bony matter around them there are no lacunæ.

B b 90. A transverse section of a Coprolite of an *Ichthyosaurus*, from the lias of Keynsham, Somerset; to the naked eye numerous brown lines are visible, these are portions of bone which on microscopic examination are plainly seen to have belonged to some osseous fish, the characteristic quadrate lacunæ being very abundant in many of the fragments.

B b 91. A transverse section of a Coprolite of another *Ichthyosaurus*, in which the portions of bone are more irregularly distributed throughout the earthy matrix; they are all more or less laminated, and lacunæ of the usual ichthyic character occur occasionally in most of the larger pieces of bone.

## Order Chelonia.

B b 92. A transverse section of the humerus of a Turtle, *Chelone Mydas*. It exhibits two kinds of structure; the bone forming the margin of the section being very compact, whilst that in the centre is more or less cancellated. In the former, the Haversian canals are very small, and each has an indistinct laminated arrangement of bony matter around it: the lacunæ between the laminæ appear small, being mostly divided in the direction of their short diameter, but in all other parts they are larger, from being cut longitudinally. The canaliculi, as in the Reptiles generally, are very much branched, and form an hexagonal network around the canals, not a series of radii, as in the Mammalia. A portion of this section, magnified 95 diameters, is represented in Plate XVII. fig. 6; the Haversian canals as there shown, have very few lacunæ in their immediate neighbourhood.

B b 93. A longitudinal section of the same bone, in which the Haversian canals are divided more or less obliquely; most of the lacunæ are arranged in parallel rows, except those in the proximity of the Haversian canals, the contour of which they closely follow. The lacunæ measure on an average the $\frac{1}{350}$th of an inch in their long diameter, and the $\frac{1}{2000}$th of an inch in their short diameter; the canaliculi are well displayed, and are generally given off at right angles to the body of the lacuna. A portion of this section is represented in Plate XVII. fig. 5.

B b 94. A transverse and a longitudinal section of the same bone, which have been mounted in Canada balsam; in some parts of the section both the canals and lacunæ are occupied by the balsam, and the bone rendered very transparent; in all the others the lacunæ and their canaliculi are plainly exhibited. The branching of the canaliculi is particularly evident in the transverse section.

B b 95. A vertical section of one of the bones composing the carapace of a large *Turtle*, being one of those to which the ribs are anchylosed; the section to the naked eye resembles that of a skull, in having an outer table, an inner table, and an intermediate structure or diploë, the lower convex portion being the section of the rib. In the outer layer or table the Haversian canals are very small and the laminæ of bone only occasionally present, but the lacunæ are very abundant; all the other parts of the section, especially the lower margin of the rib, exhibit the laminated condition of bone very beautifully, although the canals are of large size.

B b 96. A horizontal section of a portion of the same Carapace, the two margins of which are composed of dense bone, whilst the centre is more or less cancellated; the principal peculiarity to be observed is a striated structure somewhat like straight tubes of dentine, which pervades the whole of the upper margin of the section; lacunæ are very abundant, but they are mostly divided in the direction of their short diameter.

B b 97. A transverse section of one of the bones of the extremity of the gigantic fossil Tortoise of India, *Colosso-chelys Atlas*. It exhibits numerous small

Haversian canals, each having a well-developed laminated arrangement around it. The lacunæ follow the direction of the laminæ, but their canaliculi are not very evident, and each Haversian system is surrounded by a transparent line.

B b 98. A transverse section of the same bone, in which the lacunæ and canaliculi are better displayed than in the preceding section.

B b 99. A vertical section of the same bone taken from the exterior; the Haversian canals are of the usual size and divided principally in the direction of their length. The lacunæ are well seen; they occur in parallel rows, and are on an average about the $\frac{1}{1000}$th of an inch apart: their length measures the $\frac{1}{440}$th of an inch, and in breadth they equal the $\frac{1}{4000}$th of an inch. Lacunæ of an almost circular figure may also be seen, and the diameter of these is the $\frac{1}{1000}$th of an inch.

B b 100. A vertical section of the same bone, taken from the interior; it exhibits a cancellated structure; the cancelli seem to be filled with a transparent crystalline matter. The bone is exceedingly transparent, and both lacunæ and canaliculi are better displayed than in the preceding section.

B b 101. Two vertical sections of a carapace of a small Turtle, *Chelonia mydas*, both of which are traversed by numerous small Haversian canals; in the smaller section, the lacunæ are arranged in the same manner as in the transverse sections of the long bones; in the larger specimen there are longitudinal striæ, somewhat like the tubes of dentine, in addition to the lacunæ; they are disposed parallel with the long diameter of the section.

B b 102. A transverse section of the ilium of a Tortoise, *Testudo elephantopus*; the bone near the margin is very compact and traversed by Haversian canals in a radiated manner; in the centre it is cancellated, and all the canals have laminæ around them, but nearer the margin the canals are without laminæ, these being continued all round the section. The

lacunæ precisely resemble those occurring in the transverse section of the femur of the Turtle described in Preparation B b 92.

B b 103. A longitudinal section of the same bone, in which may be observed Haversian canals divided longitudinally, obliquely and transversely; the bony matter around them is more or less laminated, and the lacunæ follow the same direction as the laminæ themselves. When the lacunæ occur in parallel rows, they not unfrequently measure $\frac{1}{300}$th of an inch in length, whilst those which are of circular figure average $\frac{1}{1330}$th of an inch in diameter.

# Division II.

## HISTOLOGY OF ANIMALS.

### Subseries XVI. *Endo-skeleton of Birds.*

The bones of Birds, with few exceptions, are always hollow; they are composed of compact osseous tissue, the specific gravity of which is on an average 1·666, being with few exceptions greater than that of the other Vertebrata. The wing bones are usually so dense and white as to be capable of receiving a very high polish, like the finest ivory. The medullary cavity of the shaft of the long bones, which in Mammalia is either filled with marrow or with a cancellated tissue, is in Birds often smooth, and lined by a membrane continuous with that of the air-cells of the lungs, which gains admittance into the interior of the bones by a large opening, termed the *foramen pneumaticum*, situated in the proximal extremity of each long bone. In those birds having wings so rudimentary as not to be destined for the powers of flight, the pneumatic foramen is present in some of the long bones but absent in others; in the latter case the walls of the bones are very thick; to such an extent is this thickening carried in the Penguin tribe, that most of the bones are solid.

When sections of the bones of Birds are examined microscopically, the first thing that strikes the observer is the small size of the Haversian canals and of the lacunæ; the former are not unfrequently arranged in a direction at right angles to the long axis of the shaft of the bone, whilst the latter are remarkable for the number and the peculiar branchings of their canaliculi; in this particular, a transverse section of the bone of a bird, very much resembles that of a Crocodile and a Pterodactyle amongst Reptiles. When contrasted with a corresponding section of the bone of a mammal, the radiated disposition of the canaliculi, so characteristic of the latter, is almost entirely wanting in the Bird.

## Order Natatores.

B c 1. A transverse section of the tibia of a Patagonian Penguin, *Aptenodytes patachonica*, exhibiting a number of Haversian canals of small size, which have all been divided in a direction at right angles to their length. Each canal is surrounded by concentric systems of lacunæ, which appear of small size from the mode in which they have been cut; the canaliculi are very much branched, and like those of the Crocodile before described, form amongst themselves a delicate hexagonal network. In some parts of the section the bony matter between the canaliculi presents a minutely granular appearance, the granules being those of the earthy elements of the bone. A portion of this preparation, magnified 95 diameters, is represented in Plate X. fig. 1, and under a power of 440 diameters, in fig. 2.

B c 2. A longitudinal section of the same bone, in which the canals are divided more or less in the direction of their long diameter; they are of small size, and on each side may be seen the lacunæ disposed in parallel rows; they measure on an average $\frac{1}{800}$th of an inch in length, by $\frac{1}{4000}$th in breadth. A portion of this preparation, as seen under a power of 95 diameters, is represented in Plate X. fig. 3, and a few of the lacunæ under a power of 440 diameters, in fig. 4.

B c 3. A transverse and longitudinal section of the humerus of the same *Penguin*, both of which have been mounted in Canada balsam; most of the canals and lacunæ are filled with the balsam, but in the transverse section the former are occupied by a light brown colouring matter, somewhat resembling dried blood.

B c 4. A transverse section of the tibia of a Pelican, *Pelecanus onocrotalus*; it exhibits numerous Haversian canals of small size, each having a few laminæ around it; the lacunæ are principally divided in the direction of their short diameter, and their canaliculi, like those of birds generally, are so abundant as nearly to obscure the lacunæ from which they are derived.

B c 5. A vertical section of the same bone, exhibiting both canals and lacunæ divided in the direction of their long diameters; the lacunæ are arranged in parallel lines, and their size is tolerably uniform, measuring $\frac{1}{800}$th of an inch in the long, by $\frac{1}{4000}$th in the short diameter.

B c 6. A transverse section of the humerus of an Albatros, *Diomedæa exulans*; it is about $\frac{1}{8}$th of an inch in breadth, and on the side nearest the number may be seen a foramen for a nutritious artery. The minute structure of the bone itself is very beautiful, the canals are of small size, and the lacunæ disposed concentrically around them; the canaliculi nearest the canals are arranged in a radiated manner, but all the others are more or less branched, and by their frequent anastomosis a delicate hexagonal network is produced. A portion of this preparation, as seen under a power of 95 diameters, is represented in Plate X. fig. 5, and another portion under a power of 440 diameters, in fig. 6.

B c 7. A vertical section of the same bone in which the lacunæ are disposed in parallel rows; they are both longer and narrower than those of the Pelican, measuring on an average $\frac{1}{600}$th of an inch in the long, by $\frac{1}{5000}$th in the short diameter. A portion of this preparation, as seen under a power of 95 diameters, is represented in Plate X. fig. 7, and a few of the lacunæ under a power of 440 diameters, in fig. 8.

B c 8. A transverse section of the humerus of a Goose, *Anser palustris*; it is $\frac{1}{2}$ an inch in diameter, and about $\frac{1}{12}$th of an inch in breadth. On the side nearest the name, the Haversian canals on the inner margin are of large size and of irregular figure, but in all the other parts they are very small. The lacunæ present the usual branching character, and form the peculiar hexagonal network described in the corresponding section of the Albatros.

B c 9. A vertical section of the same bone, in which the disposition of the Haversian canals can be well seen; the lacunæ are very numerous and follow the direction of the canals; they measure on an average $\frac{1}{800}$th in the long, by $\frac{1}{4000}$th in the short diameter.

B c 10. A transverse section of the humerus of a Grebe, *Colymbus urinator*; the Haversian canals run principally in two directions, vertically and horizontally; the former are divided transversely and have a concentric arrangement of lacunæ around them; the rest, which are the most numerous, have the lacunæ arranged parallel to their walls. The lacunæ in all parts exhibit the peculiar branching of the canaliculi previously described.

B c 11. A vertical section of the same bone, exhibiting Haversian canals divided both transversely and longitudinally, a disposition resulting from the arrangement described in the first specimen; around the former the lacunæ are disposed in concentric circles, and the canaliculi are seen to have a somewhat radiated arrangement, as in the bone of Mammalia. They measure $\frac{1}{850}$th of an inch in the long, by $\frac{1}{4000}$th in the short diameter.

Order GRALLATORES.

B c 12. A transverse section of the tibia of the Water-hen, *Gallinula chloropus*. The section itself is about $\frac{1}{8}$th of an inch in diameter, and the bony matter $\frac{1}{30}$th of an inch in breadth; the inner and outer margins of the section are composed of concentric laminæ of bone, whilst the intermediate or diplöic portion contains Haversian canals divided more or less transversely, each of them having a concentric system of lacunæ around it. The canaliculi, as a general rule, are less numerous than in any specimen previously described; at the outer margin, and, in some cases, in the spaces between the Haversian systems, there are lacunæ of peculiar figure, the canaliculi of which form a coarse hexagonal network; this is particularly evident at that portion of the circumference of the section nearest the name.

B c 13. A vertical section of the same bone, in which two kinds of lacunæ may be distinguished; one of elongated form, and arranged in more or less parallel lines on either side of the Haversian canals; the other of circular figure, and so thickly aggregated together, that the canaliculi can hardly

be distinguished; these correspond with the peculiar lacunæ noticed above, the canaliculi of which form in some parts an hexagonal network.

B c 14. A transverse section of the femur of a Stork, *Ciconia alba*; the Haversian canals are of small size, and each is surrounded by a delicate hexagonal network formed by canaliculi of uniform character, and the meshes of which are of regular size and figure; this network or Haversian system has a well-defined boundary, external to which the bone is more transparent, and is furnished with lacunæ of much larger size, of irregular form, and having comparatively few canaliculi proceeding from them. A portion of this preparation is represented in Plate X. fig. 9, as seen under a power of 95 diameters, and a smaller portion in fig. 10, under a power of 440 diameters.

B c 15. A vertical section of the same bone, in which the Haversian canals are divided in the direction of their length; on either side of them may be seen elongated lacunæ with a large number of canaliculi; these form the close network alluded to in the transverse section, whilst more externally is a transparent line or band, in which are a few lacunæ having their canaliculi plainly visible; these bands form the boundaries of the several Haversian systems, also mentioned in the preceding specimen. A portion of this preparation, magnified 95 diameters, is represented in Plate X. fig. 11, and a few of the lacunæ, under a power of 440 diameters, in fig. 12.

B c 16. A transverse section of the tibia of another *Stork*, in which the two principal peculiarities alluded to in Preparation B c 14 are plainly seen; the first, being the minute hexagonal network formed by the canaliculi surrounding the several Haversian canals, the second, being the broad transparent band separating the Haversian systems from each other.

B c 17. A vertical section of the same bone, which in its general characters so nearly resembles that of Preparation B c 15, as to require no further description.

Order Cursores.

B c 18. A transverse section of the femur of a young Apteryx, *Apteryx Australis*, in which the Haversian canals are mostly divided obliquely; they are very numerous, and those on the outer margin of considerable size and full of black matter; only a few have any trace of laminated bone around them. The lacunæ are of peculiar figure, and every here and there will be seen a group in which the canaliculi are very opaque, and form a coarse hexagonal network; in some of the spaces between the canaliculi, and in many instances in the lacunæ themselves, may be noticed certain globules of a highly refracting material like oil, those in the lacunæ having very much the appearance of a nucleus.

B c 19. A vertical section of the same bone, which is remarkable for the number and peculiar arrangement of the Haversian canals; those at the extremity of the bone nearest the name, are large and funnel-shaped, but gradually diminish in size as they approach the opposite extremity. The lacunæ are very numerous, and mostly of circular figure; all those not disposed in parallel lines have, as a general rule, a coarse granular appearance.

B c 20. A transverse section of the femur of an Ostrich, *Struthio Camelus*: it is about $\frac{1}{2}$ an inch in breadth, and is remarkable for the manner in which the Haversian canals are distributed; very few run in the direction of the long axis of the bone, but most of them are seen as so many dark curved lines, running at distances of $\frac{1}{200}$th of an inch apart. The lacunæ follow the course of the canals, and are arranged with their short diameters in the direction of the section; their lacunæ are very numerous and form a minute hexagonal network, in some places very like that of the Albatros and Pelican. A portion of this preparation is represented under a power of 95 diameters in Plate XVII. fig. 3.

B c 21. A vertical section of the same bone, in which many of the Haversian canals occur in parallel lines at distances of $\frac{1}{270}$th of an inch from each

other, the lacunæ being arranged with their long diameters in the same direction; they measure on an average $\frac{1}{800}$th of an inch in the long, by $\frac{1}{4000}$th in their short diameter. A portion of this preparation, magnified 95 diameters, is represented in Plate XVII. fig. 4.

B c 22. A transverse and a longitudinal section of the femur of an *Ostrich*, both of which are mounted in Canada balsam. In the former the peculiar sinuosities of the Haversian canals are well seen, many of the Haversian systems being surrounded by a transparent band of osseous matter, as in the corresponding section of the Stork, Preparation B c 14. In the latter or vertical section, many of the canals are divided transversely, and although there is a concentric arrangement of the lacunæ around them, the radiated disposition of their canaliculi is wanting. In both sections the lacunæ and canaliculi are well displayed.

B c 23. A transverse section of the femur of a young *Ostrich*: although not more than $\frac{1}{8}$th of an inch in breadth, it still exhibits the peculiar arrangement of the Haversian canals described in Preparation B c 21, but the lacunæ are disposed in such a manner as to show more of their long diameters, they therefore appear larger than those in the section of the adult animal.

B c 24. A vertical section of the same bone, in which the canals are few in number, and principally divided transversely; most of the lacunæ are of rounded figure, and although arranged concentrically around the canals, their canaliculi are not disposed in the form of radii.

B c 25. A transverse section of the femur of a very young *Ostrich*, which, to the naked eye, exhibits a striated appearance. When viewed with a power of 100 diameters, all the bony matter will be found to be made up of a series of curved laminæ or bands, about $\frac{1}{800}$th of an inch in breadth, which are connected together by transverse portions, the intermediate space being occupied by an Haversian canal. The laminæ of the outer margin of the section are more nearly approximated than those of the

inner; all of them exhibit lacunæ, but the section having been mounted in Canada balsam, almost all traces of their canaliculi are lost.

B c 26. A corresponding section of the same bone, also mounted in Canada balsam; it exhibits the lacunæ and their canaliculi better than the preceding specimen; but the chief point to which attention should be directed is to certain crystalline bodies occupying some of the Haversian canals, which have been derived from the bone upon which the section was ground.

B c 27. A transverse section of the femur of a Dinornis, *Dinornis giganteus*, in which the canals are almost all divided in the direction of their short diameters, and around each there are two or three bony laminæ; in some situations there are as many as five or six laminæ around each canal, but the canaliculi are not arranged in a radiating manner. Many of these large Haversian systems on the inner margin of the section are surrounded by a dark line, which would appear to separate them from neighbouring systems. The canaliculi are very numerous, and their frequent branchings and anastomoses are well displayed. A portion of this preparation, magnified 95 diameters, is represented in Plate X. fig. 13, and another portion, showing the peculiar branching of the canaliculi, under a power of 440 diameters, in fig. 14.

B c 28. A longitudinal section of the same bone, in which both canals and lacunæ are well shown; the latter exceed those of the Ostrich or of any other bird in length, as may be seen by comparing fig. 16 in Plate X. with any of the corresponding figures in the same Plate; many of them are more than $\frac{1}{600}$th of an inch in their long diameter. A portion of this preparation, magnified 95 diameters, is represented in Plate X. fig. 15, and a few of the lacunæ, under a power of 440 diameters, in fig. 16.

B c 29. Two transverse sections of the femur of a Dinornis, *Dinornis didiformis*, which are of a rich brown colour from the bone having been for a long time imbedded in the mud of a river; both exhibit the same structural arrangements as those of Preparation B c 27, with the exception that

many of the Haversian canals, lacunæ and canaliculi are filled with earthy matter, whilst others are rendered transparent by the entrance of the Canada balsam.

B c 30. A transverse section of a fragment of bone sent to this country from New Zealand by Walter Mantell, Esq., with a number of bones of various species of Dinornis. The section exceeds $\frac{1}{2}$ an inch in breadth, and is as white as any recent bone; when compared with the corresponding section of the Dinornis, Preparation B c 27, it will be found to differ from it in very many points, but principally in the beautiful manner in which all the canaliculi radiate from the several Haversian canals. This bone evidently belonged to some large mammalian animal, probably an Ox, and the circumstance of its having been found in the northern islands of New Zealand, where no large mammalia co-existed with the Dinornis, is a sufficient proof that its presence there was most probably accidental.

B c 31. A transverse section of a bone, probably the femur of a large struthious bird, from the London clay of Sheppey; in its minute structure it precisely corresponds with that of the large birds previously described: the minute hexagonal network formed by the canaliculi is very evident in that part shown in Plate X. figs. 33 and 34. On the margins of the section the lacunæ are arranged in parallel rows, as represented in figs. 35 and 36; they measure $\frac{1}{800}$th of an inch in length.

*Presented by J. S. Bowerbank, Esq., F.R.S.*

Order Rasores.

B c 32. A transverse section of the femur of the Common Fowl, *Gallus domesticus*; it is $\frac{3}{10}$ths of an inch in diameter, and $\frac{1}{20}$th of an inch in breadth. On the inner margin may be noticed several foramina, two of which are probably for the transmission of blood-vessels, whilst the others form part of the air-cellules. Most of the Haversian canals run in the plane of the section, but the arrangement of the lacunæ and canaliculi precisely resembles that found in birds generally. One portion of this preparation,

magnified 95 diameters, is represented in Plate X. fig. 17, and another under a power of 440 diameters, in fig. 18.

B c 33. A vertical section of the same bone, in which may be seen lacunæ divided both transversely and longitudinally, the latter being arranged in parallel rows; the canaliculi from some of them are so numerous, as almost to obscure the lacunæ from which they are derived. The average length of the lacunæ in this bird is the $\frac{1}{1000}$th of an inch. A portion of this section, magnified 95 diameters, is shown in Plate X. fig. 19, and under a power of 440 diameters, in fig. 20.

B c 34. A transverse section of the humerus of a *Common Fowl*; it is about $\frac{1}{4}$th of an inch in diameter, and $\frac{1}{20}$th of an inch in breadth; both the outer and inner margins have laminæ of bony matter completely surrounding them, whilst in the centre are numerous Haversian canals divided both obliquely and transversely. The lacunæ are of small size, and the branching of their canaliculi may be particularly noticed.

B c 35. A longitudinal section of the same bone, in which both canals and lacunæ are divided in the direction of their long diameter; the latter are exceedingly numerous, and so are the canaliculi. In size the lacunæ precisely correspond with those in Preparation B c 33.

### Order Scansores.

B c 36. A transverse section of the humerus of a Parrot, *Psittacus viridis*, which, like that of the Common Fowl, has laminæ of bone surrounding both the outer and inner margin of the section, whilst the intermediate structure is provided with canals, around which there may occasionally be seen a concentric arrangement of the lacunæ, in which the branchings of the canaliculi are very evident. One portion of this preparation, magnified 95 diameters, is represented in Plate X. fig. 21, and another, under a power of 440 diameters, in fig. 22.

B c 37. A longitudinal section of the same bone, in which there are certain parts

provided with Haversian canals and others in which they are not present; where the canals exist as shown in Plate X. fig. 23, the lacunæ are of elongated figure and disposed in parallel lines, but where they are absent the lacunæ are circular and not arranged in any regular order. A few lacunæ are represented in fig. 24, as seen under a power of 440 diameters; some of them measure $\frac{1}{3000}$th of an inch in breadth.

Order Passeres.

B c 38. A transverse section of the tibia of a Crow, *Corvus corone*, which, like that of the Common Fowl, has laminæ surrounding the outer and inner margin of the section, whilst the intermediate portion is provided with Haversian canals, many of which have been divided in the direction of their length, whilst others of larger size are cut transversely. A bony spiculum, about $\frac{1}{30}$th of an inch in breadth, crosses the middle of the medullary cavity of the section; a trace of an Haversian canal may be observed in one part of it, but it does not extend any very great distance. A portion of this preparation is represented in Plate X. fig. 25, under a power of 95 diameters, and a few of the lacunæ, under a power of 440 diameters, in fig. 26.

B c 39. A vertical section of the same bone, in which both canals and lacunæ are well seen; the former are of larger size than those of the Fowl or Parrot, whilst the lacunæ are shorter, not measuring more than $\frac{1}{1300}$th of an inch in length. A portion of this specimen is represented in Plate X. fig. 27, under a power of 95 diameters, and another portion, containing some of the best marked lacunæ, under a power of 440 diameters, in fig. 28.

B c 40. A portion of the cranium of the great Titmouse, *Parus major*, exhibiting the openings of numerous Haversian canals which have been divided transversely; two or three rows of lacunæ may be seen surrounding each canal, they are of rounded figure, and from being so near to each other, their canaliculi are very short.

B c 41. Two specimens of the cranium of a Canary bird, *Fringilla canaria*,

which exhibit numerous lacunæ irregularly scattered amongst a few Haversian canals; in the specimen nearest the number may be seen some small processes of bone with lacunæ in them; these projected inwards towards the dura mater. The lacunæ are small in size, and between them may occasionally be seen the minute granules of bony matter.

B c 42. A similar preparation of thin bone from the cranium of a Canary bird, which exhibits the small processes or spicula of bone, the lacunæ and ossific granules, more clearly than the preceding specimen. The spicula are solid, and all exhibit lacunæ of elongated form arranged in parallel rows.

B c 43. A portion of the crest of the sternum of a Lark, *Alauda arvensis*; it is composed of two thin plates of bone, between which there is a cancellated structure: both the thin plates exhibit lacunæ, but there are certain thin spicula separating the plates from each other, in which the lacunæ are well seen; between these spicula is a cellular structure of a brown colour, which has the appearance of dried adipose tissue.

B c 44. A portion of the cranium of a Linnet, *Linaria cannabina*, in which there are no Haversian canals, but the entire thickness of the section is crowded with lacunæ; some of them are scattered about irregularly, others are disposed in parallel rows. There are two kinds, the round and the elongated; the former measure $\frac{1}{2000}$th of an inch in diameter.

B c 45. A portion of the cranium of a Bird of Paradise, *Paradisea superba*, in which two kinds of bony structure are visible: a spot nearest the name, which is of small size and brown colour, exhibits no trace of Haversian canals, but is thickly crowded with lacunæ of rounded figure. All the remaining portion of the preparation corresponds precisely with a longitudinal section of a wing bone; it exhibits Haversian canals running in parallel lines, with rows of elongated lacunæ on either side of them.

Order Accipitres.

B c 46. A transverse section of a tarso-metatarsal bone of the Great Horned Owl, *Bubo maximus*, which exhibits the same characters as the correspond-

ing sections of the bones of all the birds previously described: the network formed by the canaliculi is very well shown in this preparation. The internal cavity is divided into three compartments by two thin spicula of bone extending from one side to the other; both of these exhibit parallel rows of elongated lacunæ.

B c 47. A longitudinal section of the same bone, which is provided with Haversian canals of large size. The lacunæ, as usual, are mostly disposed in parallel rows; they are of elongated figure, and measure on an average $\frac{1}{1000}$th of an inch in their long diameter.

B c 48. A transverse section of the humerus of an Eagle, *Aquila chrysaëtos*; it is nearly half an inch in diameter and $\frac{1}{20}$th of an inch in breadth: both the outer and inner margin have laminæ completely surrounding them, and the intermediate space is occupied by Haversian canals, most of which are divided transversely, and accompanied by a concentric disposition of lacunæ with small branching canaliculi.

B c 49. A longitudinal section of the same bone, showing a portion of the central cavity; this is at the extremity of the section nearest the name, and is provided with numerous lacunæ, mostly of rounded figure; all the other parts exhibit Haversian canals divided in the direction of their length, with elongated lacunæ disposed in parallel rows on either side of them; the lacunæ seldom exceed $\frac{1}{1000}$th of an inch in their long diameter.

B c 50. A transverse section of the humerus of a Condor, *Vultur gryphus*; it is about $\frac{1}{10}$th of an inch in breadth. On both edges, especially on the inner one, laminæ are seen, having lacunæ arranged with their long diameters between them; all the other parts of the section exhibit Haversian canals divided transversely, with a concentric arrangement of lacunæ around each: the canals are of small size, and the canaliculi very numerous, precisely like those of the Ostrich, Albatros and other large birds. A portion of this preparation, magnified 95 diameters, is represented in Plate X. fig. 29, and the lacunæ, with the branching of the canaliculi, under a power of 440 diameters, in fig. 30.

B c 51. A longitudinal section of the same bone, in which both canals and lacunæ are disposed in parallel rows; the latter measure on an average $\frac{1}{800}$th of an inch. A portion of this preparation is represented in Plate X. fig. 31, under a power of 95 diameters, and a few of the lacunæ, under a power of 440 diameters, in fig. 32.

a. *Splanchno-skeleton of Birds.*

The splanchno-skeleton of Birds is represented by the zone of osseous plates supporting the cornea of the eye and surrounding its base; by the rings of the trachea, which in most cases are bony; and by a peculiar cup-like process connected with the inferior larynx of some birds, as the Duck, &c., which, it will be shown, is composed of a mass of osseous matter as thick and as highly organized as one of the bones of the extremity of the same bird. In many larger birds, such as the Turkey, the lower portions of the tendons of the muscles of the legs, as well as of some of those of the back, are converted into true bone. All these varieties of bone, forming as they do the splanchno-skeleton, resemble in their minute structure the bone from the other parts of the body, being possessed of Haversian canals, with lacunæ and canaliculi.

B c 52. A horizontal section of two of the osseous plates surrounding the cornea of the eye of a Horned Owl, *Bubo maximus*. All the parts composed of true bone, exhibit lacunæ of elongated figure; others, which are imperfectly ossified, have bundles of straight fibres amongst the lacunæ, and from the roundness of these last-mentioned lacunæ, and the fact of their occurring in parallel lines, it would appear that they are probably the cells of cartilage rather than true lacunæ. In all parts of the specimen which have not been reduced in thickness, there are numerous stellate markings of a dark brown colour; these are cells of the pigment of the sclerotic, and they occur principally on that part of the section nearest the name.

B c 53. A horizontal section of one of the bones of the sclerotic of the same *Horned Owl*, in which the lacunæ are well displayed. The entire margin exhibits a radiated fibrous structure, with lacunæ imperfectly developed between the fibres. Numerous Haversian canals are present in those parts exhibiting lacunæ, but none where the fibres exist.

B c 54. A horizontal section of two bones of the sclerotic of the same *Horned Owl*, both exhibiting certain portions, in which lacunæ occur with and without the radiating fibres. The lacunæ between the fibres are of rounded figure, and many of them have no canaliculi; in fact this preparation would tend to show that the bone was developed in a fibro-cartilaginous basis.

B c 55. A vertical section of the anterior portion of the sclerotic of a Swan, *Cygnus olor*, in which it will be seen that three distinct kinds of structure occur, viz. a layer of fibrous tissue externally, one of cartilage internally, and a portion of bone in the middle; this last is one of the osseous plates divided vertically, and it may be noticed that a considerable portion of its surface is supported upon a layer of membraniform cartilage.

B c 56. A portion of the sclerotic coat of the eye of a Canary, *Fringilla canaria*, which is composed entirely of a layer of cells of oval figure, imbedded in a structureless matrix; most of the cells contain nuclei in their interior, but there is no trace whatever of the commencement of ossification in any part of the preparation.

B c 57. A vertical section of one of the arytenoid cartilages of a Black Swan, *Anas atrata*; it consists of a framework of bone enclosing a cellular substance of a brown colour: the bone is laminated, and exhibits lacunæ of the usual form; a few Haversian canals may be seen divided transversely.

B c 58. A portion of the trachea of a Common Fowl, *Gallus domesticus*, which has been divided longitudinally, and flattened: the rings of the trachea are seen to be incompletely ossified; the opaque portions, occupying about one-half the entire circumference, indicate the bony structure, which presents lacunæ and Haversian canals; the rest of the ring is transparent, being composed of cartilage resembling the membraniform variety. The mucous membrane is injected, and shown to be most vascular where it covers the osseous structures.

B c 59. A vertical section of one of the rings of the trachea of a Black Swan, *Anas atrata*; it is bony throughout, and exhibits both canals and lacunæ of the usual form.

B c 60. A vertical section of a hollow portion of bone forming part of the inferior larynx of a Duck, *Anas boschus*; it is upwards of $\frac{1}{8}$th of an inch in thickness, and differs very little from a transverse section of a long bone of the same bird; the Haversian canals are most numerous in the centre of the section, but there is scarcely any trace of concentric laminæ around them.

# Division II.

## HISTOLOGY OF ANIMALS.

### Subseries XVII. *Endo-skeleton of Mammalia.*

The bones composing the endo-skeleton of Mammalia are, with few exceptions, less dense than those of Birds; the flat bones have internally a cancellated structure or diploë, whilst those of the extremities are hollow, the cavity being filled by a fine adipose substance termed *marrow* or *medulla*, hence its name of medullary cavity. In the Cetacea and the extinct Sloths, Megatherium and Mylodon, the medullary cavity is replaced by the ordinary cancellous tissue; this is however wanting in certain bones, as, for instance, the ribs of the Dugong and Manatee, which are entirely composed of bone as dense and compact as ivory. The long bones of the extremities, when young and growing, have their articular surfaces supported by a portion of bone distinct from that of the shaft, and termed an *epiphysis*; this, as age advances, becomes firmly united to the shaft. Epiphyses are rare in Birds, but constant in some of the Batrachia.

The minute structure of the bone of Mammalia is nearly uniform throughout the whole class, each Haversian system being surrounded by a series of concentric laminæ with lacunæ placed between them, and giving off numerous canaliculi in a radiating manner. It is a remarkable fact, however, that those Mammalia which resemble Birds in their habits or internal anatomy, approach most nearly to these animals in the minute structure of their bones; such is the case in the Ornithorhynchus, Echidna, Sloth, Kangaroo, and Bat. The minute structure of the bone in the larger Cetacea is also peculiar; the lacunæ are occasionally of large size and irregular figure, and long branching tubes, which are probably modified canaliculi, exist in most transverse sections; these are well shown in Plate XIII. figs. 7 and 9.

The exo-skeleton of Mammalia is not often present, but some well-marked examples occur amongst the Edentata, as, for instance, in the carapace of the Armadillos, and in that of the extinct Glyptodon.

The specific gravity of bone attains its maximum in the petrous element of the temporal bone in the larger Cetacea, being in the Cachalot no less than 2·433, whilst that of ivory rarely exceeds 1·744. In the Carnivora, the specific gravity of bone is also high; in the Hyæna it averages 2·144, whilst that of the Human subject is 1·877.

## Order Monotremata.

B d 1. A transverse section of the radius of an Ornithorhynchus, *O. paradoxus*; it exhibits numerous Haversian canals of small size, most of which have been divided in a direction at right angles to their length; each canal is surrounded by a few lacunæ arranged concentrically, and from these many long canaliculi are given off in the form of radii. At a short distance from the first circle of lacunæ there is generally another, and in some cases two, the canaliculi of which are larger and much branched, as in Birds; these form a well-marked boundary to each Haversian system. The inner margin of the section exhibits lacunæ of the ordinary figure, arranged between concentric laminæ, which completely surround the medullary cavity.

B d 2. A transverse section of the ulna of the same *Ornithorhynchus*, which exhibits many of the peculiarities noticed in the preceding specimen. Some of the Haversian canals are of considerable length, and projecting from their walls may be seen the radiating canaliculi; in some cases the lacunæ are so far off, that the canaliculi appear not to be derived from them, but from the canals; this is most evident on the outer margin of the section.

B d 3. A transverse section of the tibia of the same *Ornithorhynchus*, which exhibits both on its outer and inner margin a series of concentric laminæ with their accompanying lacunæ, the intermediate portion being provided

with Haversian canals. The canaliculi from all the lacunæ are of great length, especially those of the circle nearest the canal, whilst the most distant are large and few in number, and form amongst themselves an hexagonal network like that in Birds. A portion of this preparation, magnified 95 diameters, is represented in Plate XI. fig. 5, and a few of the lacunæ, in order to show the general arrangement of the canaliculi, under a power of 440 diameters, in fig. 6. At a short distance from the circumference may be noticed a ring of large lacunæ; these indicate the junction of a layer of new bone with that of the shaft.

B d 4. A vertical section of the tibia of the same *Ornithorhynchus*, which in some parts has been ground exceedingly thin, in others, especially on the straightest side, it is much thicker; in the thin part may be noticed numerous lacunæ arranged in parallel rows with very few canaliculi given off from them, but in the thicker parts both canals and lacunæ are well shown; the canaliculi nearest the canals are long and numerous, as was noticed in the transverse section. A portion of this preparation, magnified 95 diameters, is represented in Plate XI. fig. 7, and another portion, under a power of 440 diameters, in fig. 8.

B d 5. A vertical section of the radius of the same *Ornithorhynchus*, in which the Haversian canals are larger, and divided more obliquely than those in the preceding specimen. The radiating disposition of the long canaliculi in the neighbourhood of the canals, and the larger size and peculiar branchings of those most distant from them, are particularly well shown in this preparation. The longest of the lacunæ measure $\frac{1}{1000}$th of an inch, whilst those of rounded figure are on an average $\frac{1}{2000}$th of an inch in diameter.

B d 6. A transverse section of the humerus of an Echidna, *E. hystrix*; it is $\frac{1}{4}$th of an inch in diameter and $\frac{1}{20}$th broad; the arrangement of the lacunæ and canaliculi is precisely similar to that of the Ornithorhynchus, but on the whole is rather more plainly seen, in consequence of the canaliculi being longer and not quite so numerous. A portion of this preparation, magnified 95 diameters, is shown in Plate XI. fig. 1, and a few of the lacunæ,

under a power of 440 diameters, in fig. 2; the lacunæ most distant from the Haversian canals are of rounded figure, and their canaliculi much branched, as in Birds.

B d 7. A vertical section of the same bone, in which the lacunæ and their canaliculi are as plainly shown as in the preceding specimen; the latter are very long and given off with great regularity. All the lacunæ in the neighbourhood of the canals are arranged in parallel rows, as shown in Plate XI. fig. 3, but in all other parts they are scattered about irregularly, and the lacunæ themselves are of rounded figure; they are of larger size than those of the Ornithorhynchus, measuring on an average $\frac{1}{800}$th of an inch in length.

Order Marsupialia.

B d 8. A transverse section of the femur of a Kangaroo, *Macropus major*, which in its minute structure very closely resembles the bones of the Ornithorhynchus and Echidna; the row of lacunæ nearest the Haversian canals have long radiating canaliculi, whilst those more distant are shorter and have a greater tendency to branch. The Haversian canals in this specimen are all divided transversely, and the average number of laminæ around each is three; this will be found to be the character of the bones both of the Monotremata and Marsupialia, that the concentric rows of lacunæ are few and far between; the same thing exists in the Sloths, as will be readily seen by comparing figs. 1, 5, 9 and 21, in Plate XI. with figs. 13 and 17, which are corresponding sections of the bones of Rodents.

B d 9. A longitudinal section of the same bone, in which the canals and lacunæ are arranged in parallel rows; the canals vary in size; all the larger ones exhibit the radiating canaliculi on their margins like those of the Ornithorhynchus and Echidna, the first row of lacunæ being at some considerable distance, but the smaller canals have lacunæ very close to them, as will be found to be the case in most mammalian bones.

B d 10. A transverse section of the radius of the same species of *Kangaroo*, which is a thicker bone than the femur, the breadth of the section being

about $\frac{1}{6}$th of an inch. It exhibits much more clearly than Preparation B d 8, the peculiar arrangement of the lacunæ and canaliculi, many of the latter being $\frac{1}{600}$th of an inch in length ; the outer portion of the section presents a series of laminæ, which surround the entire margin, and instead of being close to each other, are at least $\frac{1}{1000}$th of an inch apart. A portion of this specimen, magnified 95 diameters, is represented in Plate XI. fig. 9, and a few of the lacunæ, under a power of 440 diameters, in fig. 10. This latter figure shows very clearly the two modes of distribution of the canaliculi.

B d 11. A longitudinal section of the same bone, in which the two kinds of lacunæ are well seen, the first provided with long canaliculi, and situated close to the Haversian canals ; the second with branching canaliculi, and occurring at a distance from them : in both there are one or more transparent spots resembling nuclei. A portion of this specimen, magnified 95 diameters, is represented in Plate XI. fig. 11, in which is seen a small Haversian canal; and another portion, including five of the lacunæ, under a power of 440 diameters, in fig. 12. The average length of the lacunæ is $\frac{1}{900}$th of an inch, their breadth $\frac{1}{4000}$th.

B d 12. A transverse section of one of the distal phalanges of a large *Kangaroo*, taken near the base, and including the horny claw which surrounded it. The claw is made up of a series of laminæ, having numerous oval cells of dark colour arranged between them ; these are cells of pigment, and to them is due the dark colour of the horn. The bone occupies the centre of the specimen, and, from having been mounted in very fluid Canada balsam, all the lacunæ and canaliculi are rendered transparent ; but the great point of interest in the section is the arrangement of the Haversian canals ; these, it will be noticed, are filled with blood which has been derived from two sources ; those canals nearest the outer margin of the bone communicate with a vascular matrix lying between the bone and the horn, whilst those on the inner margin communicate with a corresponding vascular structure occupying the medullary cavity. In several parts of the section may be seen large sinuses with which three or more canals are connected.

B d 13. A longitudinal section of one of the phalanges of a large *Kangaroo*, which, like the preceding specimen, has never been macerated, and the blood is still retained in several of the Haversian canals; these will be at once distinguished by their red colour. All those parts of the section which appear opaque to the naked eye, exhibit the lacunæ and their canaliculi very beautifully, as they have not been filled with the Canada balsam: in most of the lacunæ the transparent nuclei may be observed.

B d 14. A longitudinal section of the femur of the gigantic fossil-Kangaroo of Australia, *Diprotodon Australis*, which differs in no other respect from the corresponding section of a recent Kangaroo than in the size of the lacunæ; those of the recent animal measure $\frac{1}{900}$th of an inch in length, whilst in this specimen they exceed $\frac{1}{800}$th. The canaliculi are only visible in parts, but, judging from the distance of the first row from the walls of the Haversian canals, there is every reason to believe that the same long canaliculi, described as being present in the corresponding sections of the Monotremata, also existed in this animal.

B d 15. A transverse section of the femur of a Potoroo, *Hypsiprymnus murinus*, the outer margin of which is made up of laminæ completely surrounding the section; these are accompanied with lacunæ having long radiating canaliculi. The Haversian canals are few in number; each is surrounded with two or three circles of lacunæ; but, as in all the Marsupialia before noticed, the canaliculi nearest the canals are much longer than those in any other part of the section, in consequence of the lacunæ being at a distance.

B d 16. A longitudinal section of the same bone, which, to the naked eye, exhibits one part more opaque than the rest; this shows the Haversian canals divided obliquely, and around each the lacunæ disposed in oval rows, the first row being at some considerable distance from the canal, and the canaliculi long and wavy. The other parts of the section are transparent, the canals are few in number, and the lacunæ of rounded figure, most of them exceeding $\frac{1}{2000}$th of an inch in diameter; their canaliculi are very numerous.

B d 17. A transverse section of the humerus of a Wombat, *Phascolomys Vombatus*, which in its minute structure somewhat resembles that of the bone of the Kangaroo, but differs from it in the greater number of laminæ, and rows of lacunæ, situated around each Haversian canal. The breadth of the section in any part is not more than $\frac{1}{20}$th of an inch, but even in this narrow space three distinct kinds of lamination occur; on the outer and inner margins of the specimen the laminæ go completely round; in the intermediate portion are the Haversian canals, each of which is surrounded by laminæ varying in number from four to seven.

B d 18. A longitudinal section of the humerus of the same *Wombat*, in which most of the Haversian canals are divided obliquely; the lacunæ are of two kinds, one long and narrow, occurring in the neighbourhood of the canals, the other equally long but much broader, these last are scattered about irregularly. The canaliculi are well seen in both kinds, and as a general rule, are equal in length to the lacuna from which they are derived. The long diameter of many of the lacunæ is $\frac{1}{800}$th of an inch, the short $\frac{1}{3500}$th.

B d 19. A transverse section of the femur of a Koala, *Phascolarctos fuscus*, the circumference of which is made up of a series of laminæ, not only surrounding the margin, but occupying fully one-third of the entire breadth of the section, whilst the other parts exhibit Haversian canals which have been divided transversely; all these are surrounded with two or three broad laminæ having a few lacunæ between them, and from which numerous elongated canaliculi are given off, as in the Kangaroo before described.

B d 20. A longitudinal section of the same bone, in which both the Haversian canals and lacunæ are very well shown; it may be particularly noticed that the first row of lacunæ is at some considerable distance from the sides of the canals, and that the canaliculi, which are very numerous, are sufficiently long to reach them. This specimen is a striking one, and shows very beautifully both the lacunæ and the canali-

culi; the former frequently measure $\frac{1}{700}$th of an inch in their long diameter, the latter are on an average $\frac{1}{1200}$th of an inch in length.

B d 21. A transverse section of the humerus of a Phalangista, *Phalangista vulpina*, which, like that of the Koala, is principally made up of laminæ surrounding the entire circumference; these laminæ are plainly seen, and are on an average $\frac{1}{5000}$th of an inch distant from each other; lacunæ occur at tolerably regular distances between them, but the laminæ, it will be perceived, are made up of granular matter; no section has as yet been described in which the laminæ are so plainly marked. The Haversian canals, with their accompanying lacunæ, are also present; like the other specimens of the bones of the Marsupialia, the canaliculi are exceedingly long and numerous.

B d 22. A longitudinal section of the same bone, in which the lacunæ are beautifully displayed; their canaliculi are very abundant, and many of them of considerable length. The lacunæ are of two kinds; those occurring near the Haversian canals measure $\frac{1}{580}$th of an inch in length, and $\frac{1}{4000}$th in breadth, whilst all the others are much shorter, measuring $\frac{1}{1000}$th of an inch in length, by $\frac{1}{3000}$th in breadth; many of the lacunæ exhibit nuclei in their interior.

B d 23. A transverse section of the femur of a Petaurist, *Petaurus sciuræus*; the greater part of its surface exhibits laminæ which completely surround the entire circumference. The Haversian canals are few in number, and each is accompanied by three circles of lacunæ; all the lacunæ throughout this specimen are remarkable for the great length of their canaliculi, some of which nearly resemble the tubuli of dentine, especially in those parts where the section is so thin that the lacunæ have been almost ground away. The breadth of the circumferential laminæ is on an average $\frac{1}{1300}$th of an inch.

B d 24. A longitudinal section of the same bone, in which both canals and lacunæ are arranged in parallel rows. The lacunæ are all of elongated

figure, measuring on an average $\frac{1}{800}$th of an inch in the long diameter, by $\frac{1}{4000}$th in the short.

B d 25. A transverse section of the femur of an Opossum, *Didelphis Virginiana*; all the peculiarities characteristic of the bones of Marsupialia are well displayed in this specimen; the canaliculi immediately surrounding the Haversian canals are very long, but those forming the boundary of each Haversian system are larger, much branched, but fewer in number, a character before noticed in some Birds.

B d 26. A longitudinal section of the same bone, in which both lacunæ and canaliculi are well displayed; the latter are exceedingly numerous, and those in the immediate neighbourhood of the Haversian canals appear like so many tubes of dentine coming off from the pulp-cavity. All those parts of the section between the lacunæ, however thin, exhibit a minute granular appearance; these are due to the divided extremities of canaliculi. The longest of the lacunæ measure $\frac{1}{1000}$th of an inch.

B d 27. A transverse section of the humerus of a Dasyure, *Dasyurus viverrinus*, which exhibits both on its outer and inner margins a series of laminæ completely encircling the medullary cavity; the Haversian canals are few in number, and most of them divided obliquely; those, however, which have been divided transversely, have two or three laminæ surrounding them, but, as in the Marsupialia generally, they are some considerable distance from each other, and the canaliculi proportionately long.

B d 28. A longitudinal section of the same bone, in which the Haversian canals are very few in number, whilst the lacunæ greatly abound; these are of two kinds, the elongated form occurring in parallel rows, the rounded, scattered irregularly; the former measure on an average $\frac{1}{800}$th of an inch in length, the latter are $\frac{1}{2000}$th of an inch in diameter.

B d 29. A transverse section of the femur of a Thylacine, *Thylacinus cynocephalus*; the bony matter is $\frac{1}{5}$th of an inch in breadth, and both on the outer and inner margins are numerous laminæ, which completely surround the

section; the intermediate structure being occupied by Haversian canals with their accompanying lacunæ and canaliculi. As in all the Marsupialia previously described, the laminæ are at a considerable distance from each other, and the canaliculi proportionately long; some of the latter not unfrequently attain $\frac{1}{800}$th of an inch in length.

B d 30. A longitudinal section of the same bone, in which the Haversian canals are of large size, and not unfrequently measure $\frac{1}{800}$th of an inch in diameter. Very few of the lacunæ are arranged in parallel rows, and they are all of a more or less oval form, the long diameter being $\frac{1}{800}$th of an inch, the short frequently exceeding $\frac{1}{2000}$th.

## Order Rodentia.

B d 31. A transverse section of the humerus of a Hare, *Lepus timidus*, the outer and inner margins of which are surrounded by a few laminæ, the remainder of the specimen exhibiting small Haversian canals which have been divided obliquely; the lacunæ are more abundant than in the corresponding section of the bones of the Marsupialia, and the canaliculi much shorter, especially those nearest the Haversian canals.

B d 32. A longitudinal section of the same bone, in which both canals and lacunæ are well shown; two varieties of the latter may be easily distinguished, the elongated and the oval; they are arranged in the usual manner, and measure, the former on an average $\frac{1}{800}$th of an inch, the latter $\frac{1}{1300}$th in their long diameter, and $\frac{1}{2000}$th in the short.

B d 33. A transverse section of the femur of a Rabbit, *Lepus cuniculus*, which in its general structure precisely corresponds with that of the Hare, excepting that a slight trace of circumferential laminæ can be seen on the outer margin, but they are more abundant on the inner one. The greater part of the Haversian canals are divided obliquely; on this account most of the laminæ surrounding them are excentric.

B d 34. A longitudinal section of the same bone, in which the lacunæ are nearly

circular in figure, and measure on an average $\frac{1}{2000}$th of an inch in diameter; very few of them are arranged in parallel rows.

B d 35. A transverse section of a metacarpal bone of a Capybara, *Hydrochœrus Capybara*; both outer and inner margins exhibit circumferential laminæ, those on the inner one being by far the most numerous: the Haversian canals are of very large size, and may be seen to communicate directly with the medullary cavity. The lacunæ in their size and length of canaliculi very nearly resemble those of the Wombat; each Haversian system is surrounded by a well-defined line.

B d 36. A longitudinal section of the same bone, in which most of the canals are divided in the direction of their length; the lacunæ are principally of the rounded variety, and very few are arranged in parallel rows. The average length of those nearest the canals is $\frac{1}{1000}$th of an inch, while those at a distance measure $\frac{1}{2000}$th in diameter.

B d 37. A transverse section of the femur of a Paca, *Cœlogenys Paca*; the section is $\frac{3}{4}$ths of an inch in diameter, and the bony matter about $\frac{1}{12}$th of an inch in thickness; the circumferential laminæ are present on both margins, but the intermediate structure exhibits numerous Haversian canals, many of which may still be seen to contain blood. The intimate structure of the lacunæ and their canaliculi is precisely similar to that of the Rodentia previously described; the canaliculi around some of the Haversian canals are of considerable length.

B d 38. A longitudinal section of the same bone, in which the Haversian canals are of small size, and most of them contain traces of blood: the lacunæ are disposed in the usual manner, the longer ones measuring $\frac{1}{1000}$th of an inch, whilst the shorter do not exceed $\frac{1}{2300}$th in diameter.

B d 39. A transverse section of the tibia of an Asiatic Porcupine, *Hystrix hirsutirostris*. Both margins exhibit circumferential laminæ, in which there are but few Haversian canals; in the intermediate portion they are very numerous, and each surrounded with five concentric rows of lacunæ. It

will be noticed in this preparation that the first row of lacunæ is very close to the margin of the canal, and that the canaliculi in this situation are very short. Most of the Haversian systems are surrounded by a well-defined white line.

B d 40. A longitudinal section of the same bone, in which the lacunæ are disposed either in concentric circles, or are scattered irregularly; the Haversian canals at the extremity nearest the number are mostly divided obliquely, and each is seen to be surrounded with radiating canaliculi, which give the appearance of large oval lacunæ. Those lacunæ which are arranged in concentric circles, measure on an average $\frac{1}{800}$th of an inch in length, whilst those scattered irregularly often exceed $\frac{1}{2000}$th in diameter.

B d 41. A transverse section of the humerus of another species of *Porcupine*, which, with the single exception of being much narrower, precisely corresponds in structure with the preceding specimen. The circumferential laminæ make up the greater part of the section.

B d 42. A longitudinal section of the same bone, in which the Haversian canals are chiefly divided in the direction of their length, and the lacunæ are mostly arranged in rows parallel with them; these measure $\frac{1}{1000}$th of an inch in length, and their canaliculi are very numerous.

B d 43. A transverse section of the tibia of a Beaver, *Castor Fiber*. To the naked eye two distinct kinds of structure are apparent, one made up of concentric laminæ, the other of cancellated tissue only; when the former is examined microscopically, the laminæ are, with the exception of the corresponding section of the Phalangista, B d 21, better seen than in any preparation previously described; some few Haversian canals cross the laminæ at right angles; from these, canaliculi proceed, just like the tubes of dentine from a pulp-cavity. The cancellated structure is made up of large Haversian canals, around which are concentric laminæ and numerous lacunæ. The laminæ are at a considerable distance from each other, and

the canaliculi proportionately long: in this respect the section very much resembles that of one of the Marsupialia.

B d 44. A longitudinal section of the same bone, in which the lacunæ are principally arranged in parallel rows; they measure on an average $\frac{1}{1000}$th of an inch in length; their canaliculi are very long and well shown.

B d 45. A transverse section of the femur of a Beaver, *Castor Canadensis*, in which the entire surface exhibits Haversian canals divided obliquely. The circumferential laminæ are wanting; the free margin exhibiting lacunæ of irregular figure, which probably are in process of growth: the lacunæ and canaliculi correspond in general appearance with those in Preparation B d 43. A segment of this section is represented in Plate XI. fig. 17, magnified 95 diameters, and a portion of the same, exhibiting a few of the lacunæ, under a power of 440 diameters, in fig. 18.

B d 46. A longitudinal section of the same bone, in which two kinds of lacunæ are very evident; one of elongated figure, occurring in the neighbourhood of the Haversian canals, the other more or less rounded, and situated, generally, in the interspaces of the several Haversian systems. Both kinds are represented, under a power of 95 diameters, in Plate XI. fig. 19, and under a power of 440 diameters, in fig. 20. The former measure on an average $\frac{1}{1000}$th of an inch, whilst the latter are seldom more than $\frac{1}{1500}$th in diameter. On the edge of the section nearest the name, may be seen some of the peculiar lacunæ described as occurring on the outer margin of the transverse section.

B d 47. A transverse section of the humerus of a Water Rat, *Arvicola amphibia*. It is principally made up of concentric laminæ, as in the Mouse; but in those parts which are broader than the rest, there are a few canals with concentric laminæ and lacunæ: the canaliculi of these lacunæ are much fewer in number than those connected with lacunæ in other parts.

B d 48. A vertical section of the same bone, in which two kinds of lacunæ may be seen; the elongated form are met with only on that side of the section

nearest the number, all the others being of a rounded form; the canaliculi from these last are so numerous, that they almost obscure the lacunæ from which they are derived. The elongated kind measure, on an average, $\frac{1}{1000}$th of an inch, the others frequently exceed $\frac{1}{2000}$th of an inch in diameter.

B d 49. A transverse section of the femur of a Rat, *Mus Rattus*; the circumferential laminæ exist on the outer margin only, the remainder of the section being occupied by Haversian canals divided both obliquely and transversely; the former have laminæ around them, which assume an oval figure, whilst in the latter they are circular and fewer in number. Two kinds of lacunæ are present. A segment of this section, magnified 95 times, is represented in Plate XI. fig. 13; and a portion, in which the two kinds of lacunæ are seen, in fig. 14. The elongated kinds occur in the neighbourhood of the Haversian canals.

B d 50. A longitudinal section of the same bone, exhibiting similar appearances to those of the Beaver before described; the Haversian canals are of small size, but the elongated form of lacunæ is most abundant. A portion of this preparation, magnified 95 diameters, is represented in Plate XI. fig. 15; and a few of the lacunæ, magnified 440 times, in fig. 16. They are, as a general rule, shorter and broader than those of the Beaver, seldom exceeding $\frac{1}{1800}$th of an inch in length.

B d 51. A transverse section of the femur of another *Rat*, taken from near the centre of the shaft. The circumferential laminæ are very evident on the outer margin, but are wanting on the inner; the lacunæ in the former situation being so close together, that their canaliculi cannot be well made out, but everywhere else they are very evident.

B d 52. A transverse section of the femur of a Mouse, *Mus musculus*; it is $\frac{1}{35}$th of an inch in diameter, and the breadth of the bony matter is on an average $\frac{1}{400}$th of an inch. The principal peculiarity to be noticed in this section, is the entire absence of Haversian canals, the medullary cavity supplying their place, and the laminæ being arranged concentrically

around it; in this particular, the section corresponds precisely with those of the long bones of the Menopome, Axolotl and Siren, as shown in Plate VIII., and with that of the ribs of the Boa. One-third of this preparation is represented in Plate XII. fig. 1, under a power of 95 diameters, and a segment of the same, under a power of 440 diameters, in fig. 2.

B d 53. A longitudinal section of the same bone, in which the lacunæ are arranged principally in parallel rows; they are mostly of that form which has been denominated oval, and measure on an average $\frac{1}{1000}$th of an inch in the long by $\frac{1}{3000}$th in the short diameter. A portion of this specimen, magnified 95 diameters, is represented in Plate XII. fig. 3, and a few of the lacunæ, under a power of 440 diameters, in fig. 4.

B d 54. A transverse section of the humerus of a Marmot, *Arctomys Marmotta*: as in the Beaver, Rat, and other Rodentia before noticed, both the inner and outer margins of the section are surrounded with circumferential laminæ, which are crossed by a few Haversian canals, the greater part of these being situated in the intermediate portion, and each canal accompanied by a concentric arrangement of laminæ and lacunæ of the usual form.

B d 55. A longitudinal section of the same bone, in which are three kinds of lacunæ, the round, oval and elongated, the latter occurring in the neighbourhood of the Haversian canals, the other two being scattered about without much order. The elongated lacunæ measure $\frac{1}{1000}$th of an inch, the oval $\frac{1}{1500}$th in the long by $\frac{1}{2000}$th in the short diameter, the round $\frac{1}{2000}$th in diameter.

B d 56. A transverse section of the femur of a Squirrel, *Sciurus vulgaris*, the diameter of which is $\frac{1}{5}$th of an inch, whilst the breadth of the bone itself is not more than $\frac{1}{40}$th. All the narrow parts exhibit concentric laminæ only, whilst those which are thicker are provided with Haversian canals in addition to the laminæ. This specimen, in the thinness of its bony matter, resembles certain Birds, and amongst the Mammalia it approaches

most nearly to the Bats. The lacunæ and their canaliculi are well seen, as are also the laminæ near the outer margin.

B d 57. A longitudinal section of the same bone, in which the Haversian canals are very few in number and of small size; the lacunæ in their neighbourhood are arranged in parallel rows, and measure on an average $\frac{1}{1000}$th of an inch in length by $\frac{1}{3000}$th in breadth; in other parts of the section they are of rounded figure, and exceed $\frac{1}{2000}$th of an inch in diameter.

Order Bruta.

B d 58. A transverse section of the humerus of an Armadillo, *Dasypus Peba*. The breadth of the bony matter is $\frac{1}{20}$th of an inch; most of the Haversian canals are divided obliquely, so that the concentric arrangement of the laminæ around them is only occasionally to be seen. The lacunæ near the circumference have but few canaliculi, but those disposed concentrically around the canals have them long and wavy, so that this part of the section corresponds with that of a bone of a Kangaroo.

B d 59. A longitudinal section of the same bone, in which the Haversian canals are much branched; the lacunæ in their neighbourhood are of the elongated form, and are remarkable for the length of their canaliculi; the others are mostly of oval figure, but very broad in proportion to their length, and some are nearly circular. The elongated form measures about $\frac{1}{700}$th of an inch in length; the oval $\frac{1}{1300}$th of an inch in length by $\frac{1}{2000}$th in breadth; and some of the more circular are $\frac{1}{1500}$th in diameter; the canaliculi from this last variety form a hexagonal network, somewhat like that previously described in Birds.

B d 60. A transverse section of the tibia of the gigantic Armadillo, *Glyptodon clavipes*, which, although very much infiltrated with earthy matter, serves to show that the Haversian canals are of small size, and that the concentric laminæ surrounding them are very numerous: the lacunæ are

plainly seen in some situations, but very little can be made out of the arrangement of the canaliculi.

B d 61. A longitudinal section of the same bone, in which the Haversian canals are divided in the direction of their length; they are of small size, and very numerous. Lacunæ, with their canaliculi, are in some situations sufficiently distinct to be measured, and the average long diameter of the former is $\frac{9}{100}$th of an inch.

B d 62. A transverse section of the left ramus of the lower jaw of the same *Glyptodon*, which is very much infiltrated with earthy matter, but on the concave edge all the parts that appear yellow to the naked eye, exhibit very clearly both Haversian canals and their laminæ; the lacunæ are also very evident in some situations.

B d 63. A transverse section of the femur of a Manis, *Manis pentadactyla*, which to the naked eye presents two distinct kinds of structure; one forming the outer margin of the section is dense and laminated, the other exhibiting large Haversian canals. In the former the lacunæ are of small size, and provided with large wavy canaliculi, which form amongst themselves a coarse hexagonal network, somewhat similar to that described as existing in Birds, and in the *Echidna* and *Ornithorhynchus* among Mammalia; the Haversian canals in this part of the bone are of small size, and run principally in the plane of the section; there is no trace of the concentric arrangement of lacunæ around them. The remaining portion of the section is precisely like most other mammalian bones; the Haversian canals being divided transversely, and each having lacunæ disposed concentrically around it: the canaliculi are very long; in this particular also the structure agrees with that of the Monotremata.

B d 64. A longitudinal section of the same bone, in which the two kinds of structure, previously noticed in the transverse section, are here also exhibited. In the circumferential portion, the lacunæ are of peculiar figure, and arranged without much order; all of them are provided with very

large canaliculi. In the remaining portion, the Haversian canals are disposed in parallel rows, and the lacunæ accompany them; these are of the usual form, and no other peculiarity is observable than that of the great length of their canaliculi. The lacunæ measure on an average $\frac{1}{800}$th of an inch in this part of the section.

B d 65. A transverse section of the femur of a Two-toed Sloth, *Cholœpus didactylus*; the diameter of the section is $\frac{1}{4}$th of an inch, and the centre in its natural condition was occupied by cancellated tissue; only a trace of this now remains: the entire surface exhibits Haversian canals, which have been divided transversely; they are of small size, and those near the cancellated tissue, as in the Manis, are surrounded with concentric laminæ and lacunæ with radiating canaliculi, but those near the circumference have only a slight trace of laminæ around them, and the canaliculi form amongst themselves a network, in many respects resembling that noticed in Birds. A portion of this section, exhibiting the Haversian canals, and the concentric arrangement of lacunæ, is represented in Plate XI. fig. 21, and another portion, showing the great length of the canaliculi, under a power of 440 diameters, in fig. 22.

B d 66. A vertical section of the same bone, in which the canals and lacunæ are arranged in parallel rows; the latter measure on an average $\frac{1}{800}$th of an inch in length, but there are some few occasionally met with which exceed $\frac{1}{700}$th.

B d 67. A transverse section of the femur of a Three-toed Sloth, *Bradypus tridactylus*, which, both in size and minute structure, corresponds with that of the two-toed species previously described; the Haversian canals nearest the outer margin have only traces of laminæ around them, but on the inner one, each canal has as many as five or six; the lacunæ between them are remarkable for the length of their canaliculi, which are arranged in the form of radii, whilst those nearer the circumference are wavy, and approach more closely to those of Birds.

B d 68. A longitudinal section of the same bone, in which both canals and

lacunæ are well displayed; two kinds of the latter may be observed, one of elongated figure, occurring in the neighbourhood of the canals, the other rounded, and situated at a distance from them: the canaliculi from both kinds are very long, and in certain situations a hexagonal network is produced by them; the length of many of the lacunæ is $\frac{1}{450}$th of an inch, $\frac{1}{600}$th of an inch being a fair average; many of them exhibit nuclei very plainly.

B d 69. A transverse section of one of the digital phalanges of a *Three-toed Sloth*. Like the section of the femur, the centre is occupied by cancellated tissue, the cancelli exhibiting Haversian canals, and having a concentric laminated arrangement around them, the canals being divided transversely. All the other parts of the section are made up of circumferential laminæ, parallel with which, the canals may be seen. The lacunæ are remarkable for the great number of their canaliculi.

B d 70. A longitudinal section of the same bone, in which only a few canals are present, and these occur in that part of the section nearest the name; the lacunæ are of peculiar figure, and do not follow the course of the canals, as in the corresponding section of the femur. The extremity nearest the number has a portion of its articular cartilage present; this may be known by certain dark-coloured cells, of large size and rounded figure. The bone was in a state of epiphysis, and the cells of cartilage may be seen arranged in vertical columns, in that part of the section corresponding to the junction of the epiphysis with the shaft.

B d 71. A transverse section of one of the ribs of the great extinct Sloth, *Megatherium Cuvieri*, in which numerous Haversian canals are present, but the lacunæ, with very few exceptions, have been destroyed; from the great number of laminæ surrounding each canal, and the radiated structure still present, there is every reason to believe that both lacunæ and canaliculi must have been very abundant. In some of the spaces between the Haversian systems a few lacunæ are still to be seen.

B d 72. A longitudinal section of the same rib, in which the canals and lacunæ

may still be seen; they are both arranged in parallel rows, and all the spaces between the lacunæ present a minutely granular appearance, resulting from the divided extremities of the canaliculi. The specimen is mounted in Canada balsam, and most of the lacunæ are in consequence rendered very indistinct.

B d 73. A longitudinal section of the same rib, which has been polished on both surfaces, and mounted in a dry state; the canals and lacunæ are more plainly seen than in the preceding specimen, and in many situations the lacunæ and their canaliculi are both almost as distinct as they are in a recent bone; the latter it will be noticed are very long and wavy. The average length of the lacunæ is $\frac{1}{900}$th of an inch, the breadth $\frac{1}{3000}$th, being of much smaller size than those of the recent Sloths.

B d 74. A transverse section of the tibia of the extinct Sloth, *Mylodon robustus*. Two kinds of structure are visible to the naked eye, one external in the form of a dense layer nearly $\frac{1}{4}$th of an inch in thickness, the other more open and broader; the first represents the true shaft of the bone, the last the cancellated interior, the bone showing no medullary cavity. All parts of the section exhibit very plainly both Haversian canals and lacunæ; the former are surrounded with so many laminæ, that an Haversian system often fills the whole of the field of view of the microscope; the canaliculi are of considerable length, and resemble those of the recent Sloths.

B d 75. A longitudinal section of the same bone, in which both canals and lacunæ are as well seen as in a section of recent bone mounted in Canada balsam. The lacunæ in the neighbourhood of the canals are arranged in parallel rows, and are of elongated figure, those more distant being rounded; the former are remarkable for their length, many of them exceeding the $\frac{1}{550}$th of an inch; some few are unusually broad in proportion, being upwards of $\frac{1}{2000}$th of an inch. It will be noticed that the lacunæ of the Megatherium are considerably smaller than those of this animal.

B d 76. A transverse section of one of the metacarpal bones of the Great Ant-eater, *Myrmecophaga jubata*, which is remarkable for the beauty of its minute structure. On the outer margin, the lacunæ are of irregular figure, and their canaliculi, which are of large size and few in number, form amongst themselves a coarse hexagonal network; a little nearer the inner margin, the Haversian canals make their appearance, they are surrounded by very few laminæ, and the lacunæ between them are remarkable for the length of their canaliculi. In all the remaining portions of the section the canals are of large size, and the lacunæ with their canaliculi well displayed; the latter are of considerable length, and very much resemble those of the Two-toed Sloth.

B d 77. A longitudinal section of the same bone, in which the Haversian canals are divided both longitudinally and obliquely, and the lacunæ are met with as two distinct varieties, the round and the elongated; the former measuring on an average $\frac{1}{2500}$th of an inch in diameter, the latter $\frac{1}{700}$th of an inch in length and $\frac{1}{4000}$th in breadth.

B d 78. A vertical section of one of the parietal bones of the *Great Ant-eater*, which, like other sections of the bones of the cranium, consists of an outer and inner table and a diploë. In its minute structure it corresponds with a transverse section of a long bone, exhibiting Haversian canals divided transversely, and each surrounded with concentric laminæ having lacunæ between them, which in this particular instance have very long canaliculi.

B d 79. A horizontal section of the same bone, which in its minute structure precisely corresponds with the longitudinal section of the metacarpal bone, B d 77; both canals and lacunæ are well shown, the latter measuring on an average $\frac{1}{700}$th of an inch in length; the canaliculi are very numerous, and their distribution clearly exhibited.

## Order Insectivora.

B d 80. A transverse section of the femur of a Hedgehog, *Erinaceus europæus*, in which nearly all the Haversian canals run more or less obliquely, and

there are only one or two spots in the whole section in which concentric laminæ exist; the lacunæ are very abundant, and are disposed in curves which follow the course of the canals. A segment of this preparation, magnified 95 diameters, is represented in Plate XII. fig. 5, and a portion of the same, under a power of 440 diameters, in fig. 6, from which it will be seen that the arrangement of the canaliculi is rather in the form of a coarse network than as a series of radii.

B d 81. A longitudinal section of the same bone, in which the Haversian canals in that part of the specimen nearest the number are divided obliquely, whilst those near the opposite extremity are cut in the direction of their length; in this latter situation they are arranged in parallel lines, and are so close together that only one or two rows of lacunæ occur between them; at the extremity nearest the number they are wider apart, and may be seen to communicate freely by anastomosing branches, as represented under a power of 95 diameters, in Plate XII. fig. 7. The lacunæ are mostly of elongated figure, and measure on an average $\frac{1}{1000}$th of an inch in length; many of them are very broad in proportion to their length.

B d 82. A transverse section of the humerus of a Mole, *Talpa europæa*, taken from the upper part where the bone is flattest; the section measures $\frac{3}{10}$ths of an inch in length, and $\frac{1}{10}$th in breadth. It resembles the corresponding section of the Hedgehog in the general arrangement of the Haversian canals, most of which are disposed in the plane of the section; consequently the laminæ, although very numerous, are not concentric, but disposed in wavy lines. A portion of this preparation is represented in Plate XII. fig. 9, under a power of 95 diameters, and a few of the lacunæ, which are principally divided in the direction of their short diameter, in fig. 10.

B d 83. A longitudinal section of the same bone, taken from that part in which the shaft is most cylindrical; it is on an average $\frac{1}{12}$th of an inch in breadth. There is a slight indication of a medullary cavity or of a cancellated structure at one end, but the Haversian canals are few in number, where

they occur the lacunæ will be seen arranged in parallel rows, but in all other parts of the section they are scattered about irregularly. A portion of this specimen, exhibiting two Haversian canals and the parallel arrangement of the lacunæ, is represented, under a power of 95 diameters, in Plate XII. fig. 11; and another portion, under a power of 440 diameters, in fig. 12: the lacunæ measure on an average $\frac{1}{1000}$th of an inch in length: like those of the Hedgehog, they are broad in proportion to their length; those situated in the centre of the section are of oval figure, and, as a general rule, do not exceed $\frac{1}{1330}$th of an inch in their long diameter.

Order Cheiroptera.

B d 84. A transverse section of the humerus of a large species of Bat (*Pteropus*); it is $\frac{1}{6}$th of an inch in diameter, and the bony matter is $\frac{1}{40}$th of an inch in breadth; as in the Mouse and Water-Rat before described, there are no Haversian canals, laminæ alone being present, and these completely surrounding the medullary cavity, with lacunæ and radiating canaliculi between them.

B d 85. A longitudinal section of the same bone, in which there is no trace of an Haversian canal, but all the lacunæ are disposed in parallel rows; they are of tolerably uniform size, measuring on an average $\frac{1}{1000}$th of an inch in length; some few are as long as $\frac{1}{900}$th.

B d 86. A transverse section of the humerus of another species of Bat (*Pteropus*), the breadth of the bone of which is greater than that of the last-described specimen. The circumferential laminæ occur in all parts of the section, except the centre, where a few Haversian canals will be seen; these are of small size, and each has from one to three laminæ around it. A segment of this section, including the entire breadth of the bony matter, is represented in Plate XII. fig. 13. In this view three small Haversian canals will be noticed: in fig. 14, a portion of the same section is shown, magnified 440 times: the canaliculi form among themselves a network of elongated meshes.

B d 87. A longitudinal section of the same bone, in which traces of one or two small Haversian canals, divided in the direction of their length, may be seen, at the end nearest the name. The lacunæ are very numerous and disposed in parallel rows ; they measure on an average $\frac{1}{900}$th of an inch in length, being rather larger than those of the preceding species of Bat. A portion of the section, showing two canals magnified 95 diameters, is represented in fig. 15 ; and a few of the lacunæ, under a power of 440 diameters, in fig. 16.

B d 88. A transverse section of the humerus of a large *Bat* from Australia, which is $\frac{1}{4}$th of an inch in diameter, and the bony matter $\frac{1}{20}$th in breadth. On the side nearest the number may be seen a canal for the nutritious blood-vessel ; nearly the whole of the section exhibits laminæ, which pass round the entire circumference, with the exception of one spot, where a few small Haversian canals exist ; these occur on that side of the section nearest the name.

B d 89. A longitudinal section of the same bone, in which several canals may be noticed, and two kinds of lacunæ, the elongated and the rounded : the former are disposed in parallel rows nearest the canals, whilst the others occur in the spaces between the several Haversian systems. The first-named measure on an average $\frac{1}{900}$th of an inch, some of them reaching $\frac{1}{800}$th : the round seldom exceed $\frac{1}{2500}$th in diameter.

B d 90. A horizontal section of the vertebra dentata of the same species of *Bat*, which is almost entirely made up of cancellated tissue : all the cancelli, however thin, exhibit lacunæ, and the thicker ones, Haversian canals in addition. On the upper surface the odontoid process is seen in section ; its free edge exhibits the peculiar lacunæ characteristic of all articular surfaces, being of large size, very opaque, and having few canaliculi.

B d 91. A transverse section of the humerus of a smaller species of *Bat*. It is about $\frac{1}{12}$th of an inch in diameter, the breadth of the bone being $\frac{1}{48}$th ; the medullary cavity is consequently of small size. All parts of the section except the central ones, exhibit concentric laminæ and lacunæ, but in the

centre a few Haversian canals, with long wavy canaliculi connected with them, may be observed. The canaliculi in every part of the section are very long and wavy, resembling those of the Ornithorhynchus and Echidna.

B d 92. A longitudinal section of the same bone, exhibiting several Haversian canals, which occur at nearly equal distances from each other: the lacunæ are all arranged in parallel rows, and their canaliculi are very numerous. Those nearest the circumference of the section are longer and narrower than those nearer the centre, and some of them attain to the great length of $\frac{1}{650}$th of an inch, whilst their breadth is less than $\frac{1}{4000}$th. Those in the centre of the section are on an average $\frac{1}{800}$th of an inch in length, their breadth being in some cases $\frac{1}{3000}$th. The very long lacunæ in this specimen more nearly resemble those of the Pterodactyle than any mammalian animal before described.

B d 93. A thin portion of one of the parietal bones of a small English Bat, *Vespertilio Noctula*, which has been mounted in Canada balsam without having been ground on either surface. Small patches of rounded lacunæ occur in various parts of the specimen; their canaliculi are very numerous, and each appears to have a dilated extremity: the bone in which they are imbedded, exhibits very plainly the ultimate granules of the earthy matter.

## Order Cetacea.

B d 94. A transverse section of a rib of the large Whalebone Whale, *Balæna mysticetus*; on the outer convex surface the bony matter is very compact, but towards the centre it becomes more and more cancellated. Like a corresponding section of the shaft of a long bone, this specimen exhibits numerous Haversian canals, around which are laminæ and lacunæ; the latter are few in number, and, as a general rule, are not so regularly disposed as in other mammalia. The canaliculi are in some cases remarkable for their length, and are given off from the lacunæ in straight lines, crossing the laminæ as so many radii. The principal peculiarities to be

observed in this specimen, and some of which are characteristic of the bones of the Cetacea generally, are,—1st, the granular character of the bony matter itself; 2ndly, the comparatively few lacunæ around each Haversian canal; and 3rdly, the presence in certain situations of long dark lines or tubes, which are probably modified lacunæ or canaliculi. A portion of this section, magnified 12 diameters, is seen in Plate XIII. fig. 1, and one of the Haversian canals, showing the laminæ magnified 95 times, in fig. 2; a few of the lacunæ are represented under a power of 440 diameters, in fig. 3. The specific gravity of the bone from which the section was taken is 1·818.

B d 95. A longitudinal section of the same rib, in which the Haversian canals are divided in various directions; whenever they are seen running straight, for however short a distance, the lacunæ occur in rows parallel with their walls, but in other situations they are scattered about without much order. A portion of this preparation is shown in Plate XIII. fig. 4, under a power of 95 diameters, and the lacunæ as there exhibited differ very considerably in size; but the same thing is better seen in fig. 5, where a few of them are represented as viewed under a power of 440 diameters. Some of them measure $\frac{1}{666}$th of an inch in length; the majority are considerably shorter and broader, some of them are nearly circular, and frequently exceed $\frac{1}{1500}$th of an inch in diameter. Like the transverse section, the granular structure of the bony matter is very apparent.

B d 96. A transverse section of a portion of the right ramus of the lower jaw of a Finner Whale, *Balænoptera Boops*. Like that of the last-described species, the Haversian canals are very numerous, and each surrounded with laminæ of considerable breadth. The lacunæ and canaliculi are few in number, and on this account the extent of the granular condition of the bony matter is more plainly seen; in some parts of the section large spaces occur, in which the granules only are visible.

B d 97. A similar preparation, which has been mounted in Canada balsam; the Haversian canals are of small size, and some of them are occupied by a

reddish-brown substance, which is probably blood. The lacunæ are few in number, and amongst them may be seen some of large size and very irregular figure, from which the peculiar canaliculi previously described are given off. The granular condition of the earthy matter is very evident in this specimen.

B d 98. A longitudinal section of the same bone, also mounted in Canada balsam; the Haversian canals are mostly divided obliquely, and the parallel arrangement of the lacunæ is only here and there present. The principal peculiarity exhibited by this section, is the abundance of the large fibres or tubes before alluded to; they frequently occur in company with the lacunæ, and occasionally are disposed in the form of radii around the Haversian canals. Some of them present a granular structure, whilst others appear as if they were made up of bundles of tubes, like canaliculi.

B d 99. A similar preparation, which has been ground very thin, and shows the lacunæ, tubes, and granular condition of the earthy matter, more plainly than the last-described specimen. The lacunæ are principally of two kinds; some of them are precisely like those of the mammalia generally, being of elongated form, whilst others are of very irregular figure, somewhat resembling those occurring near the articular surfaces of long bones. The first kind measure $\frac{1}{700}$th of an inch in length, and about $\frac{1}{4000}$th in breadth; others are of circular figure, and frequently exceed $\frac{1}{1330}$th of an inch in diameter.

B d 100. A vertical section of one of the vertebral epiphyses of a large Finner Whale, *Balænoptera Boops*: it corresponds precisely in its minute structure with a transverse section of a long bone. The same peculiarities before noticed in the other sections of the bones of the Cetacea, are in this one very plainly shown. The lacunæ are not so close together as they are in bones generally, but in certain situations the large tubuli described as being present in the other sections, are here seen to be connected with lacunæ. On the smooth upper edge, which was the

articular one, the peculiar large opaque lacunæ characteristic of these parts occur in considerable numbers.

B d 101. A transverse section of the lower jaw of a Cachalot, *Physeter macrocephalus*, which, like the specimens previously described, exhibits Haversian canals, around which numerous indistinct laminæ are arranged. The lacunæ and their canaliculi are both few in number, and the granules of the bony matter are everywhere conspicuous.

B d 102. A transverse section of another portion of the lower jaw of a *Cachalot*, which appears to have been taken from a part more dense than the preceding specimen. The Haversian canals are very numerous and of small size, and the breadth of the laminæ around them very plainly marked; both lacunæ and canaliculi are few in number, but the granules of the bony matter are so numerous as to render the greater part of the section opaque.

B d 103. A transverse section of the right ramus of the lower jaw of another *Cachalot*, which has been mounted in Canada balsam. It exhibits a few Haversian canals, divided transversely, each having a small number of laminæ around it, the largest proportion of laminæ being disposed in a series of wavy lines, which appear to surround all the Haversian systems. Some idea may be formed of the disposition of the laminæ by examining fig. 6, Plate XIII., which is a representation of the entire section as seen under a power of 12 diameters. In fig. 7, two of the Haversian systems are shown under a power of 95 diameters; these will serve to show the small number of the lacunæ and the presence of the long tubuli before noticed. The lacunæ, when divided in the transverse direction, appear of small size, and in this specimen they do not measure more than $\frac{1}{1500}$th of an inch in length: a few of them are represented in fig. 8, as seen under a power of 440 diameters.

B d 104. A longitudinal section of the same bone, in which the Haversian canals are very plainly seen; they are few in number and of large size,

their walls are clearly defined, and most of them contain a brown-coloured material, which is probably blood. The laminæ form a series of arches, and both lacunæ and the peculiar tubular structure before mentioned are well shown in this preparation, as may be seen in Plate XIII. fig. 9, which is a representation of a portion of this specimen magnified 95 diameters. The lacunæ, as a general rule, are arranged in parallel rows, and their canaliculi are better seen in this section than in any which have preceded it; the former measure on an average $\frac{1}{800}$th of an inch in length, the canaliculi being much longer than this, which is readily accounted for by the great breadth of the laminæ. Some of the linear markings, which have been described as tubuli, have a granular appearance in this section. Five of the lacunæ are represented in fig. 10, as seen under a power of 440 diameters.

B d 105. A transverse section of the rib of a *Cachalot*, which exhibits more plainly than any of the preceding specimens the structure of Cetacean bone; the Haversian canals are very numerous, and around each may be seen the laminæ and lacunæ: the canaliculi are long and wavy, and, as in the other sections, are more abundant in those lacunæ situated between the Haversian systems, than in those surrounding the canals.

B d 106. A transverse section of the tympanic bone of a *Cachalot*, in which the Haversian canals are of small size and very few in number: the lacunæ are abundant in some situations, but, as a general rule, have very few canaliculi. The specific gravity of the bone from which this section was taken was 2·437, which may be accounted for by the scarcity of the canals and of the lacunæ; the granular condition of the earthy matter is everywhere apparent.

B d 107. A transverse section of the same tympanic bone, which has been mounted in Canada balsam; the Haversian canals are very few in number, and have scarcely any laminæ around them, these last being arranged principally in parallel rows. The lacunæ follow the course of the laminæ; they are of two kinds, one of the usual form, the other, as a general rule, of very irregular figure, with canaliculi large in proportion, and

not given off in the same uniform way as those in the bones of other mammalia.

B d 108. A longitudinal section of the same tympanic bone, in which the Haversian canals will be found divided principally in the direction of their length ; many of them will be found filled with blood. The same peculiar lacunæ, described in the preceding specimen, are very abundant ; they may at once be known by their opacity. In this and the two preceding sections of the tympanic bone the lacunæ are of small size, seldom attaining to the length of $\frac{1}{1000}$th of an inch.

B d 109. A transverse section of the tympanic bone of a Grampus, *Delphinus orca*, which is nearly as dense as that of the Cachalot : the Haversian canals, although very numerous, are of small size, rarely exceeding $\frac{1}{1500}$th of an inch in diameter : there is no trace of concentric laminæ, and the lacunæ, as a general rule, are scattered about irregularly ; there are, however, one or two spots in which they will be found arranged in parallel rows, and many of them attain to the great length of $\frac{1}{600}$th of an inch, their breadth rarely exceeding $\frac{1}{4000}$th : the canaliculi are large in proportion ; these, however, are few in number, the common kind measuring on an average $\frac{1}{1000}$th of an inch. The specific gravity of this specimen is 2·4064.

B d 110. A longitudinal section of the same tympanic bone, in which the canals are of small size, and the lacunæ of peculiar figure, as alluded to in the preceding specimen, except the long variety of lacunæ, which in this section appear to have been divided transversely : the canaliculi are all given off more or less in a radiated manner ; they frequently branch and form amongst themselves an irregular network.

B d 111. A transverse section of the tympanic bone of a small Cetacean ; the specimen from which the section was taken is about $\frac{1}{3}$rd less than that of the preceding, but although the general arrangement of the canals and lacunæ is the same, the first glance will show that they are both much larger. Those canals which are divided transversely have both laminæ

and lacunæ arranged concentrically around them, the latter being of elongated figure and very narrow ; in the spaces between the Haversian systems the lacunæ are much larger, and their canaliculi more numerous and remarkable for their frequent branchings.

B d 112. A longitudinal section of the same bone, which, were it not for the peculiar disposition of the Haversian canals, could hardly be distinguished from the preceding specimen. The lacunæ are of various forms, some round, others oval and much elongated ; the canaliculi from all kinds are very long and numerous, and have a frequent tendency to form a minute network amongst themselves, but as they principally occur in groups, there is a large space of bone between them in which none exist. Some of the lacunæ in this specimen measure $\frac{1}{600}$th of an inch in length, and $\frac{1}{3000}$th in breadth ; others are $\frac{1}{1300}$th in diameter : a few of oval figure measure $\frac{1}{900}$th of an inch in length, and $\frac{1}{2000}$th in breadth.

B d 113. A transverse section of the humerus of a Dolphin, *Delphinus tursio* ; both the outer and inner margins present a cancellated structure, but the intermediate portion is very dense ; lacunæ of the usual mammalian figure are present in every part ; their canaliculi are disposed in a radiated manner around the Haversian canals : it will be at once seen that this specimen bears a much closer resemblance to bones of mammalia generally than that of any of the Cetacea which have preceded it.

B d 114. A longitudinal section of the same bone, which is much cancellated, but all the closer portions exhibit numerous small Haversian canals, most of which have been divided either obliquely or transversely, very few longitudinally. The lacunæ and their canaliculi are well shown ; they are precisely like those of ordinary mammalian bone both in form and arrangement ; they measure on an average $\frac{1}{800}$th of an inch in length : the canaliculi are very long and numerous ; a few of the elongated markings, previously mentioned, also exist in this specimen.

B d 115. A transverse section of the lower jaw of a common Dolphin, *Delphinus delphis*, exhibiting a cancellated structure on one edge, the other being

very dense; it corresponds precisely with a transverse section of a long bone in exhibiting numerous small Haversian canals surrounded with laminæ and lacunæ. The lacunæ are mostly divided in the direction of their short diameter, their canaliculi are long and delicate. A portion of this preparation, magnified 95 diameters, is represented in Plate XIII. fig. 11; in it the small size of the Haversian canals may be noticed: in fig. 12 a few of the lacunæ are represented; the smaller ones occurred around the Haversian canals, the two larger in the Haversian interspaces. A mere inspection of fig. 11 will at once show how much more closely this specimen resembles in its minute structure the bone of an ordinary mammal, than do the corresponding sections of any of the larger Cetacea.

B d 116. A longitudinal section of the same bone, in which both canals and lacunæ are divided in the direction of their long diameter. The lacunæ are arranged in parallel rows, and their canaliculi are remarkably distinct; some of the former measure $\frac{1}{800}$th of an inch in length, the average size being about $\frac{1}{900}$th. One of the Haversian canals, and its accompanying lacunæ, are represented in Plate XIII. fig. 13, under a power of 95 diameters; and a few of the lacunæ are shown in fig. 14 under a power of 440.

B d 117. A transverse section of the humerus of a Porpoise, *Delphinus phocæna*, nearly every portion of which is more or less cancellated; at the extremity nearest the name the bone is more compact, and Haversian canals may be seen, each surrounded with laminæ and lacunæ; the latter are of the usual form, and the section agrees generally with that of a long bone of a mammalian animal.

B d 118. A longitudinal section of the same bone, which, like the transverse one, is more or less cancellated; very few Haversian canals are present, but in every case the lacunæ in their neighbourhood are disposed in parallel rows, whilst in all other parts they are scattered about irregularly, and are of rounded figure, those near the canals being elongated, the

former measuring on an average $\frac{1}{2500}$th of an inch in diameter, the latter $\frac{1}{1000}$th of an inch in length. The granular condition of the earthy matter is very evident on the edges of most of the canals and cancelli.

B d 119. A transverse section of the humerus of another *Porpoise*; the bone is of a yellow colour, but is rather more dense than that of the preceding specimen. The Haversian canals are well shown, each having from three to five laminæ around it, but the lacunæ between these laminæ are not quite so numerous as in mammalian bone generally.

B d 120. A longitudinal section of the same bone, which precisely corresponds in its minute structure with that of Preparation B d 119, with the single exception that all parts of the bony matter are tinged of a yellow colour.

B d 121. A transverse section of a rib of a *Porpoise*; it is of an oval figure, and contains a large central cavity, and although $\frac{3}{10}$ths of an inch in its long, and $\frac{2}{10}$ths in its short diameter, the breadth of the bone is not more than $\frac{1}{30}$th of an inch. The entire surface exhibits Haversian canals, which have been divided transversely, each having its accompanying laminæ and lacunæ, as may be seen in Plate XIII. fig. 15, which is a representation of a portion of this section, magnified 95 diameters. The lacunæ when viewed with a power of 440 diameters, present the appearance shown in fig. 16.

B d 122. A longitudinal section of the same rib, which, like a corresponding section of the shaft of a long bone, exhibits Haversian canals and lacunæ arranged in parallel rows, except in those parts corresponding with the spaces between the Haversian systems, in which they are disposed without much order. A portion of this specimen, including one of the canals, is represented in Plate XIII. fig. 17, under a power of 95 diameters, and five of the lacunæ, under a power of 440 diameters, are seen in fig. 18; they measure on an average $\frac{1}{900}$th of an inch. The section is very thin

on one edge, and in this part are no Haversian canals, but the lacunæ are of rounded figure, and give off numerous delicate radiating canaliculi; their average diameter is $\frac{1}{2000}$th of an inch.

B d 123. A transverse section of the humerus of a Narwhal, *Monodon monoceros*; like that of the Cachalot, it was solid throughout, and its specific gravity 2·179. The Haversian canals are of large size, and surrounded with numerous granular laminæ: the lacunæ are few and far between, as in the large Whales before noticed; those surrounding the canals are remarkable for the delicacy of their canaliculi, whilst most of the others in the Haversian spaces have very few canaliculi. All the bony matter presents a well-marked granular appearance.

B d 124. A longitudinal section of the same bone, one edge of which is very dense and formed the exterior of the shaft, the other being cancellated and situated in the interior; both exhibit canals and lacunæ: the latter are disposed in the usual manner, those nearest the canals occurring in parallel rows, the others following no regular order; the longest specimens measure on an average $\frac{1}{900}$th of an inch.

B d 125. A transverse section of the rib of a Dugong, *Halicore indicus*, which, in its general characters, closely resembles a corresponding section of the shaft of a long bone of a terrestrial mammal. The Haversian canals, as a general rule, are of small size, and the laminæ around them very broad, the canaliculi being in consequence very long, and in some situations so numerous that the bony matter between them can scarcely be seen. A portion of this specimen, magnified 95 diameters, is represented in Plate XIII. fig. 19, and a few of the lacunæ, as seen under a power of 440 diameters, are shown in fig. 20; both these specimens serve to exhibit the great length of the canaliculi. In some parts of the section the elongated tubuli are very abundant.

B d 126. A longitudinal section of the same rib, in which both canals and lacunæ are well shown; the latter are disposed principally in parallel rows, and their canaliculi are very long and numerous. Some of the

lacunæ in the neighbourhood of the canals are of considerable length, measuring not unfrequently $\frac{1}{600}$th of an inch, $\frac{1}{700}$th being a fair average; occasionally the canaliculi are so long and so close together, that they resemble the tubuli of dentine. A portion of this preparation, as seen under a power of 95 diameters, is represented in Plate XIII. fig. 21; and four of the lacunæ are shown in fig. 22, under a power of 440 diameters.

B d 127. A transverse section of the rib of the same *Dugong*, which has been mounted in Canada balsam; all the lacunæ and their canaliculi are filled with this substance, so that both are rendered indistinct, but the linear markings which have been described as resembling tubuli, still remain. This preparation serves to show the difference in texture between the Haversian systems and the spaces between them, the former being opaque and granular, the latter transparent, and exhibiting traces of black lacunæ and the tubuli before mentioned.

B d 128. A longitudinal section of the same rib, which has also been mounted in Canada balsam; nearly all traces of the lacunæ and canaliculi are lost, but the linear or tubular structure is brought prominently into view. It occurs in the Haversian spaces, and may be described as consisting of a series of fibres arranged in oblique lines; some of them turn upon themselves and form a series of arches, others continue a diverging course and become smaller and smaller, like the tubuli of dentine.

B d 129. A transverse section of the humerus of the same *Dugong*, which has been mounted in Canada balsam; the lacunæ and their canaliculi are as well seen as in the section of rib forming Preparation B d 125. Each Haversian system is well marked by its lacunæ, and by the great number of the radiating canaliculi, as well as by a peculiar opacity which has been alluded to in Preparation B d 127; whereas all the Haversian interspaces are transparent, and the lacunæ there situated are always of more or less irregular figure.

B d 130. A longitudinal section of the same bone, also mounted in Canada

balsam ; the canals, lacunæ, canaliculi and linear markings are all very plainly exhibited ; the canaliculi are so numerous in some situations, that even the lacunæ from which they are derived can hardly be recognized ; in all other respects this section agrees with that of the rib of the same animal which forms Preparation B d 126.

B d 131. A transverse section of a rib of a Manatee, *Manatus americanus*, which, like that of the Dugong, is solid throughout and nearly as dense, and capable of receiving as high a polish as ivory. The Haversian canals are of small size, and the laminæ surrounding them very broad ; the lacunæ are disposed between them in the usual manner; their canaliculi are long and delicate, those nearest the canals are arranged in the form of radii, the others form a hexagonal network amongst themselves. A portion of this preparation, magnified 95 diameters, is represented in Plate XIII. fig. 23, and in fig. 24 are seen a few of the lacunæ, showing the arrangement of the canaliculi, under a power of 440 diameters.

B d 132. A longitudinal section of the same rib, in which all the structures are well displayed, especially the lacunæ and their canaliculi, the former being arranged in parallel rows; they are larger than those of the Dugong, measuring on an average $\frac{1}{650}$th of an inch ; the canaliculi are very long and numerous. A portion of this specimen, as seen under a power of 95 diameters, is represented in Plate XIII. fig. 25, and in fig. 26, a few of the lacunæ magnified 440 diameters.

B d 133. A transverse section of the basilar process of the occipital bone of the same *Manatee*, the greater part of which is made up of cancellated tissue, but on one edge it is very compact : with the exception of the cancelli, this section corresponds in structure with a transverse one of a long bone ; the Haversian canals are surrounded with three or four rows of large lacunæ, the canaliculi of which are long and numerous. On the thick edge the linear markings may be observed.

B d 134. A longitudinal section of the same bone, which, like the preceding, is

almost wholly composed of cancellated tissue; as a general rule the lacunæ are disposed in parallel rows, but in all the broader portions of the bone, Haversian canals occur, and then, a more or less concentric arrangement of the lacunæ takes place. This section agrees in its general characters with a similar one taken from a long bone, and the lacunæ present every variety of figure, from a circle measuring $\frac{1}{1300}$th of an inch in diameter, to an oval, the long diameter of which is $\frac{1}{600}$th, and the short $\frac{1}{4000}$th of an inch.

## Order Proboscidea.

B d 135. A transverse section of the tibia of an Elephant, *Elephas indicus*, the breadth of which is half an inch; when viewed with the naked eye, three kinds of structure are apparent, one on the circumference, more or less cancellated, the second on the inner margin, dense and more transparent than the rest, whilst the third or intermediate portion exhibits a curved, laminated appearance. In all the three portions there are Haversian canals and lacunæ divided transversely, but in the central one most of the canals run in the plane of the section. The lacunæ are nearly all of uniform size, and their canaliculi are of considerable length and given off with great regularity; most of the Haversian systems are surrounded with a well-marked transparent line. A portion of this specimen, magnified 95 diameters, is represented in Plate XII. fig. 17, and a few of the canaliculi under a power of 440 diameters in fig. 18.

B d 136. A longitudinal section of the same bone, the edges of which are more or less cancellated, the intermediate portion being very dense and exhibiting numerous laminæ arranged longitudinally; in the cancellated portions there are few Haversian canals, but they are very numerous in the dense part, and are arranged in parallel rows with lacunæ between them. A portion of this specimen, magnified 95 diameters, is represented in Plate XIII. fig. 19; and five of the lacunæ, under a power of 440 diameters, in fig. 20; it will at once be seen that they are of great length,

most of them exceeding $\frac{1}{580}$th of an inch. The specific gravity of the bone from which the section was taken is 2·088.

B d 137. A transverse section of the femur of a fossil Elephant, from the tertiary formations of the Sub-Himalayan district; it exhibits numerous Haversian canals transversely divided, and so many concentric laminæ around each, that frequently one Haversian system more than fills the field of view of the microscope. The lacunæ may still be recognized, but the canaliculi, which were very numerous, can only be judged of by the radii crossing the several Haversian laminæ. The entire section is of a light brown colour, the bone in all probability having been impregnated with a solution of iron.

B d 138. A longitudinal section of the same bone, in which both canals and lacunæ are arranged in parallel rows; the latter are of large size, and in some few spots their canaliculi are well displayed. This section, like the preceding, is not only tinged of a light brown colour, but colouring matter of the same description can plainly be seen to have filled many of the lacunæ; the latter are broader but not so long as those of the recent animal, measuring $\frac{1}{800}$th of an inch in length, and $\frac{1}{3000}$th in breadth.

B d 139. A transverse section of the femur of a *Mastodon*, which is so much impregnated with earthy matter in some parts of its surface, that little trace of structure can be seen, but in others both the lacunæ and their canaliculi are very apparent, and are disposed in the usual manner; as in the Indian species, the Haversian systems are of large size.

B d 140. A portion of the animal basis of the bone of a *Mastodon*, from the Arctic regions, in which traces of the lacunæ are still present; but the most important feature connected with it is its granular condition, an appearance resulting from its having been impregnated with earthy matter in the same divided state as that shown by the markings.

*Presented by Sir John Richardson, F.R.S.*

## Order Perissodactyla.

B d 141. A transverse section of the radius of a Rhinoceros, *Rhinoceros indicus*, which, with the exception of a little cancellated structure on the edge, is very dense throughout. A few circumferential laminæ are found on the outer convex margin, but in all other parts the section is made up of Haversian canals divided transversely, and surrounded with concentric laminæ and lacunæ. The Haversian systems are of small size, but each is bounded by a well-marked transparent line; all are remarkable for the regularity both in size and number of the lacunæ.

B d 142. A radial section of the same bone, in which both the laminæ and lacunæ are remarkably well shown, the latter always following the course of the former and being of two principal varieties, the elongated and the circular, the one measuring $\frac{1}{800}$th of an inch in length and $\frac{1}{4000}$th in breadth, the other frequently exceeding $\frac{1}{2000}$th of an inch in diameter: the canaliculi from both kinds are very long and delicate.

B d 143. A tangental section of the same bone, in which the Haversian canals are divided either longitudinally or transversely. The laminæ are only visible in the neighbourhood of some of the canals, but wherever they occur the lacunæ between them are always of the elongated form: the Haversian systems are separated by a transparent line, in which the lacunæ are of circular figure, and their canaliculi given off in the form of radii. The length of the lacunæ precisely agrees with those in the radial section, but the breadth, as a general rule, is greater, being $\frac{1}{3000}$th.

B d 144. A transverse section of the radius of a fossil *Rhinoceros*, which, in its minute structure, precisely corresponds with that of the recent bone described in Preparation B d 141. The Haversian systems are small and very numerous, and the lacunæ with their canaliculi disposed in a regular manner. The spaces between the Haversian systems are well

marked, the lacunæ being both larger and more opaque than they are in any other part of the section.

B d 145. A longitudinal section of the same bone, in which the canals and lacunæ are arranged in parallel rows, and both more or less filled with a rich brown colouring material. Some portions of the section are perfectly transparent, others exhibit a dotted or a fibrous structure; both appearances resulting from the great number of the divided canaliculi.

B d 146. A transverse section of the tibia of a Tapir, *Tapirus indicus*, the walls of which are $\frac{1}{2}$ an inch in thickness, and like that of the Rhinoceros and Elephant, the bony matter is very dense. On the outer convex margin there is only a slight trace of circumferential laminæ, small Haversian canals occurring almost on the very edge, these gradually increase in size as they approach the opposite margin; the lacunæ and their canaliculi are disposed in a very regular manner.

B d 147. A longitudinal section of the same bone, in which there is a nearly parallel disposition of the Haversian canals, the laminæ and lacunæ; the latter measure on an average $\frac{1}{800}$th of an inch in length; their canaliculi are so numerous, that when divided either transversely or longitudinally, the bony matter between them can hardly be seen.

B d 148. A transverse section of the ulna of the same *Tapir*, which has been mounted in Canada balsam; all the points of interest noticed in Preparation B d 146 are more plainly seen in this specimen, especially the boundaries of each of the Haversian systems: many of the canals are filled with blood.

B d 149. A longitudinal section of the same bone, taken from its distal articular extremity; a portion of the cancellated structure of the interior is present on one edge. Like the preceding specimen the lacunæ are well shown, but in many cases they have been rendered transparent by the entrance of the balsam.

B d 150. A transverse section of the femur of the Hyrax, *Hyrax capensis*; it is $\frac{1}{4}$ of an inch in diameter, and the breadth of the bony matter is $\frac{1}{20}$th of an inch. Like the corresponding bones of the smaller Rodentia this one is almost wholly made up of laminæ, which pass completely round the section, but every here and there, about midway between the inner and outer margins, are a few small Haversian canals divided transversely, with only one or two concentric laminæ around them, the other canals are divided obliquely.

B d 151. A longitudinal section of the same bone, in which the Haversian canals run principally in an oblique direction, so that in some cases the lacunæ are disposed in concentric circles, in others in parallel rows; they measure on an average $\frac{1}{800}$th of an inch in length, and their canaliculi are very abundant.

B d 152. A transverse section of the right metacarpal bone of a Horse, *Equus caballus*; the bone is very dense, and measures $\frac{3}{10}$ths of an inch in breadth. On the outer and inner margins numerous laminæ may be observed, which extend the entire length of the section; the space between the two, exhibits numerous Haversian canals which have been divided transversely, each having its accompanying system of laminæ and lacunæ, the latter being arranged with the greatest regularity.

B d 153. A longitudinal section of the same bone, in which most of the canals are divided in the direction of their course; on either side of them may be seen the parallel laminæ with their accompanying elongated lacunæ, and external to the laminæ are the Haversian spaces, in which the lacunæ are of rounded figure, and the laminæ hardly perceptible. The average length of the lacunæ is $\frac{1}{1100}$th of an inch; very few of them exceed $\frac{1}{1000}$th; some of the round ones measure $\frac{1}{2000}$th of an inch in diameter.

B d 154. A transverse section of the femur of a *Horse*, which has been mounted in Canada balsam; with the exception of one edge, which is very thin,

the lacunæ and their canaliculi are even better seen than in Preparation B d 152; many of the new Haversian systems having an undulated outline, as described by Messrs. Tomes and De Morgan, are plainly seen.

B d 155. A longitudinal section of the same bone, also mounted in Canada balsam; the lacunæ are arranged in the same way as those of Preparation B d 153, but from some of the canaliculi being rendered transparent, their size can be easily ascertained, and it will be found that they are somewhat larger than in that specimen, the average length being $\frac{1}{1000}$th, whilst some few even attain to the length of $\frac{1}{800}$th of an inch.

B d 156. A transverse section of the fibula of a *Horse*, found with some Roman remains; it corresponds precisely, in its minute structure, with that of Preparation B d 152, in exhibiting numerous Haversian canals divided transversely, each with its concentric arrangement of laminæ and lacunæ. The section is of a rich brown colour, and all the canals on the circumference are filled with rust-coloured material.

B d 157. A portion of the ethmoid bone of a *Horse*, which is sufficiently thin to be examined without grinding; it is full of canals of nearly equal size, and the bone around them is free from laminæ, and exhibits numerous oval lacunæ disposed irregularly, not concentrically, as in the shaft of a long bone. These lacunæ measure on an average $\frac{1}{1300}$th of an inch in their long diameter, and $\frac{1}{3000}$th in the short; they resemble those occurring in the Haversian spaces in a transverse section of a long bone.

B d 158. A transverse section of a cannon bone of a fossil *Horse* from the Himalayas, mounted in Canada balsam; it exhibits the same appearances as Preparation B d 152, but all the lacunæ and their canaliculi are rendered transparent by the balsam, except those into which a brown-coloured material has entered; these will be found on the edge nearest the number. In some cases the lacunæ of an entire Haversian system,

in others only a few are filled with the colouring matter, but the canals in every case are occupied by it.

B d 159. A longitudinal section of the same bone, in which all the Haversian canals, and many of the lacunæ are filled with a brown-coloured material, the others being transparent and exhibiting no trace of canaliculi. A portion of this specimen is represented in Plate XV. fig. 19; it serves to show that the canaliculi and lacunæ are hollow, and that both can without doubt be filled from the Haversian canals. The colour of the contained material renders this specimen peculiarly interesting.

B d 160. A transverse section of the left ramus of the lower jaw of an Ass, *Equus asinus*; the Haversian canals are of large size, and many of them are surrounded with concentric laminæ and lacunæ; the latter are of two kinds, the elongated and the round, the one measuring on an average $\frac{1}{800}$th of an inch in length, the other $\frac{1}{2000}$th of an inch in diameter; in both, the canaliculi are very numerous.

B d 161. A transverse section of a cannon bone of a Zebra, *Equus zebra*, which, in its general characters, precisely resembles the section of the corresponding bone in the Horse: very few circumferential laminæ are to be observed on the outer margin, but they are abundant on the inner. Nearly all the Haversian canals are divided transversely, and both laminæ and lacunæ are disposed with great regularity around them. Some of the Haversian systems exhibit an undulating margin, whilst others are smooth and separated from the interspaces by a transparent band, in which are lacunæ of peculiar figure.

B d 162. A longitudinal section of the same bone, in which the Haversian canals are very numerous, and arranged principally in parallel rows; the lacunæ in the neighbourhood of the canals follow the same course, and are of elongated figure, whilst those which are situated in the Haversian spaces are shorter and broader. The transparent bands before noticed as forming the boundary of some of the Haversian systems can be occa-

sionally seen in this section; the average length of one of the elongated lacunæ is $\frac{1}{900}$th of an inch, those of rounded figure often exceeding $\frac{1}{2000}$th in diameter.

Order Artiodactyla.

B d 163. A transverse section of the femur of a Pig, *Sus scrofa*; the breadth of the bony matter is $\frac{3}{20}$ths of an inch: to the naked eye it presents a laminated appearance, arising from the disposition of the Haversian canals, which are arranged in a series of curved lines parallel with the margins of the section; between some of them may be noticed other canals which have been divided transversely. The laminæ and lacunæ, as a general rule, follow the course of the canals, and when these are divided transversely, a few concentric laminæ surround them. On the inner edge nearest the name are a few Haversian canals divided transversely, each surrounded with eight or ten laminæ, as in corresponding sections of mammalian bones in general. The lacunæ are all of more or less elongated form, and their canaliculi disposed in a radiated form; between some of the rows a transparent line or band may be seen, the margins of which are formed by a row of lacunæ having branching canaliculi; these form a peculiar network, the meshes of which appear to be occupied by small refracting bodies like nuclei. The arrangement of the Haversian canals in the plane of the section is very common in the bones of the larger Birds.

B d 164. A longitudinal section of the same bone, in which most of the canals are divided transversely, but very few of them are surrounded with concentric laminæ, the majority of the laminæ being disposed in parallel rows, and these are accompanied with lacunæ, which give off a great number of canaliculi. The lacunæ themselves are almost all of the oval variety, and measure $\frac{1}{1000}$th of an inch in the long, and $\frac{1}{3000}$th in the short diameter.

B d 165. A transverse section of a metacarpal bone of a Peccari, *Dicotyles torquatus*, which, on one part of its circumference, exhibits a series of

laminæ, whilst on the remainder the laminæ are not only absent, but the bone is very transparent, and the lacunæ of peculiar figure, somewhat like those described in the transverse section of the femur of the Pig, Prepaparation B d 163, there being an appearance of small cells in the spaces between the branches of the canaliculi. All the other parts of the section exhibit either Haversian canals divided transversely with their accompanying lacunæ and canaliculi, or laminæ continued between the several Haversian systems, and round the inner margin of the bone.

B d 166. A longitudinal section of the same bone, in which the canals and laminæ are arranged in parallel rows, except in the situations corresponding with the Haversian spaces; in these, the laminæ are either not present or are very indistinct. Elongated lacunæ occur between the laminæ, but the rounded form prevails in the Haversian spaces; the former measure $\frac{1}{1200}$th of an inch in length; the latter are $\frac{1}{3000}$th of an inch in diameter; it will therefore be seen that the lacunæ of this animal are of smaller size than those of the Pig.

B d 167. A transverse section of the humerus of a Hippopotamus, *Hippopotamus amphibius*: like the bones of the larger mammalia already described, it consists of a series of Haversian canals transversely divided, each with its accompanying concentric arrangement of laminæ and lacunæ. The Haversian systems are so closely packed together, that the Haversian spaces are of small size; in some of them may be seen a few of the peculiar lacunæ noticed in the Pig. The outer margin exhibits only a slight trace of circumferential laminæ. A portion of this preparation, magnified 95 diameters, is represented in Plate XII. fig. 21, and a segment of two of the Haversian systems, under a power of 440 diameters, in fig. 22.

B d 168. A longitudinal section of the same bone, in which the greater number of the Haversian canals are divided obliquely; some of them have parallel rows of lacunæ on either side, whilst around others they are disposed more or less concentrically; all the intermediate portions of bone exhibit no traces of laminæ, and the lacunæ in such situations are of rounded figure with radiating canaliculi; those between the laminæ

being elongated, and their canaliculi given off as radii from two sides only. The round variety of lacuna measures $\frac{1}{2000}$th of an inch in diameter; the elongated average $\frac{1}{900}$th of an inch in length, and $\frac{1}{4000}$th in breadth. A portion of this preparation, magnified 95 diameters, is represented in Plate XII. fig. 23, and a few of the lacunæ, under a power of 440 diameters, in fig. 24.

B d 169. A transverse section of a metacarpal bone of a *Hippopotamus*, which has been ground much thinner than the corresponding section of the humerus, B d 167, especially on the outer margin; with this exception the minute structure of both precisely agrees.

B d 170. A longitudinal section of the same bone, which, with the exception of being rather thinner, agrees precisely in structure with that of B d 168: the length of the longest lacunæ is $\frac{1}{800}$th, but the majority are nearer $\frac{1}{900}$th of an inch.

Order Ruminantia.

B d 171. A transverse section of a digital phalanx of a Camel, *Camelus bactrianus*, which, with the exception of the inner margin, is entirely made up of Haversian systems, divided transversely; these are of small size, and some of them exhibit large spaces which are very transparent from the absence both of lacunæ and canaliculi; on the inner margin the laminæ completely surround the wall of the medullary cavity, and it will be noticed that the layer of bone last formed has separated slightly from the other portion of the section.

B d 172. A longitudinal section of the same bone, in which the canals, laminæ and lacunæ are mostly arranged in parallel rows; the lacunæ are well displayed; those between the laminæ are all of the elongated form, their canaliculi passing across at right angles to the laminæ; the others are either oval or circular, and their canaliculi given off in a radiated manner. The elongated lacunæ are on an average $\frac{1}{800}$th of an inch in length, and $\frac{1}{5000}$th in breadth; the oval $\frac{1}{1000}$th of an inch in length, and $\frac{1}{3000}$th in breadth; the circular $\frac{1}{2000}$th of an inch in diameter.

B d 173. A transverse section of the tibia of the same *Camel*, which precisely agrees in its minute structure with that of Preparation B d 171, with the exception of the larger size of the Haversian systems, and the more perfect distribution of the lacunæ and their canaliculi, the only transparent spots being some of the Haversian interspaces. In this section may be seen two or three well-marked instances of cavities having an undulating margin, as represented by *a* in Plate XVI. fig. 17.

B d 174. A longitudinal section of the same bone, in which all the canals are well displayed; they run in parallel lines, and are accompanied with lacunæ remarkable for the great number of their canaliculi. Midway between most of the Haversian canals may be seen a transparent band or line, in which are lacunæ of rounded figure with radiating canaliculi; these correspond with the several Haversian interspaces. Many of the lacunæ in this specimen refract light very strongly, as if they contained oily matter.

B d 175. A transverse section of a digital phalanx of a Llama, *Auchenia Llama*; like the Camel, it exhibits circumferential laminæ on its inner, but not on the outer margin, and the remainder of the section is made up of small Haversian systems, having on an average five laminæ around them: several of the openings having an undulating margin, like that noticed in the corresponding section of the Camel, may be seen; in some of them the commencement of the formation of a new system is very apparent; these are the Haversian spaces of Messrs. Tomes and De Morgan.

B d 176. A longitudinal section of the same bone, in which the Haversian canals and their collateral branches are well shown. All the parts of the section nearest the canals exhibit laminæ and elongated lacunæ, in the others the lacunæ are mostly of rounded figure; the elongated kind measure on an average $\frac{1}{1000}$th of an inch; some of them are not more than $\frac{1}{5000}$th in breadth, others $\frac{1}{3000}$th: those of circular form are much larger than usual, being $\frac{1}{1330}$th in diameter, the majority being above $\frac{1}{2000}$th.

B d 177. A transverse section of a metatarsal bone of a Musk-Deer, *Moschus moschiferus,* exhibiting circumferential laminæ on both outer and inner margins; in the greater part of the surface the Haversian canals are divided transversely, and the bone is made up of a number of Haversian systems; in other parts they are divided obliquely, and the Haversian systems are of oval instead of circular figure; the canals themselves are of very small size, especially those near the outer margin, which have only one or two laminæ around them.

B d 178. A longitudinal section of the same bone, in which the Haversian canals of the centre are divided in the direction of their length, and those of the margin obliquely. The lacunæ are arranged in the usual manner, and are all very broad in proportion to their length, the longest rarely being $\frac{1}{1000}$th of an inch; the average is about $\frac{1}{1330}$th; their breadth attains the $\frac{1}{4000}$th. The circular variety, as a general rule, exceeds $\frac{1}{2000}$th of an inch in diameter.

B d 179. A transverse section of the humerus of the Napu Musk-Deer, *Moschus Napu*; it is $\frac{1}{4}$th of an inch in diameter, and the bony matter about $\frac{1}{30}$th in thickness. Like the corresponding sections of the smaller Rodents, this is made up principally of concentric laminæ; the Haversian canals are of very small size, and, as a general rule, are arranged in curves, very few of them exhibiting any trace of laminæ around them.

B d 180. A longitudinal section of the same bone, in which most of the canals occur in the plane of the section, so that their transverse connecting branches are well seen; there is little or no trace of a laminated arrangement, and the lacunæ are mostly of oval figure, the longest that can be found not exceeding $\frac{1}{900}$th of an inch in length, the greater number being less than $\frac{1}{1200}$th.

B d 181. A transverse section of a metacarpal bone of the extinct Irish Deer, *Megaceros Hibernicus,* which, like that of the Ruminants before described, is made up of a large number of Haversian systems. The canals are

very minute, and each is surrounded with laminæ and lacunæ ; the bony matter is of a light brown colour.

B d 182. A longitudinal section of the same bone, in which the Haversian canals are principally arranged in parallel lines, each with its accompanying rows of laminæ and lacunæ ; these last are of two kinds, the elongated and the oval ; some of the former measure as much as $\frac{1}{800}$th of an inch in length, but the latter rarely exceed $\frac{1}{1000}$th of an inch in their long diameter. The canaliculi are very long and delicate, and quite as well seen as in a recent bone.

B d 183. A transverse section of a digital phalanx of an Irish Deer, which is about $\frac{1}{8}$th of an inch in breadth ; it is made up of small Haversian canals in the middle, and of a series of curved laminæ on either side, through which some of the Haversian canals pass as so many radii. The lacunæ and their canaliculi are as well seen in this specimen as in one of recent bone.

B d 184. A longitudinal section of the same bone, in which some of the Haversian canals can be traced from one end to the other ; a few are divided obliquely. The lacunæ and their canaliculi are so numerous that the bony matter can hardly be seen between them ; most of the former are either of oval or circular figure, the one measuring $\frac{1}{1000}$th of an inch in the long diameter and $\frac{1}{3000}$th in the short, the other being on an average $\frac{1}{2000}$th in diameter.

B d 185. A transverse section of the femur of a Rein-Deer, *Cervus Tarandus*, exhibiting circular laminæ on both margins, the intermediate portion being occupied by Haversian systems, either of circular or elongated figure ; in one or two spots there are traces of the formation of new Haversian systems, as before described. The lacunæ and their canaliculi are exceedingly well displayed.

B d 186. A longitudinal section of the same bone, in which the Haversian canals are divided in three principal directions, either transversely,

obliquely, or longitudinally, each having its corresponding arrangemen of laminæ and lacunæ : the latter are of the two usual forms, the elongated and the oval, the former measuring $\frac{1}{800}$th of an inch in length, the latter $\frac{1}{1000}$th in length and $\frac{1}{2000}$th in breadth.

B d 187. A transverse section of the tibia of a Fallow Deer, *Cervus Dama*, which at the end nearest the name is made up of a series of small Haversian systems, the canals being divided transversely, whilst on the thin edge the canals run in curved lines, as in the corresponding section of the Pig, B d 163. Two of the spaces described by Messrs. Tomes and De Morgan are present, but neither of them exhibits any trace of a new deposit on their edges. One specimen has been mounted in Canada balsam, and both lacunæ and canaliculi are well seen.

B d 188. A longitudinal section of the same bone, in which most of the canals have been divided either longitudinally or obliquely, and the lacunæ are arranged either in parallel or curved rows, or scattered about without much order. The longest of the lacunæ measure $\frac{1}{1000}$th of an inch, others are on an average $\frac{1}{1330}$th in length and $\frac{1}{3000}$th in breadth, but the circular kind is seldom less than $\frac{1}{2000}$th of an inch in diameter, many even exceed the $\frac{1}{1500}$th.

B d 189. A transverse section of a metatarsal bone of a Giraffe, *Camelopardalis Giraffa*; it is upwards of half an inch in breadth, and to the naked eye exhibits many Haversian spaces. Circumferential laminæ are very abundant both on the outer and inner margins of the section, especially the former, but the remainder of the specimen is made up of a series of compact Haversian systems with their accompanying laminæ and lacunæ; some of the spaces above described show a deposit of one or of two laminæ on their internal surface.

B d 190. A longitudinal section of the same bone, one edge of which exhibits parallel laminæ crossed at right angles by Haversian canals; this corresponds to the inner surface of the bone; the remainder exhibiting canals running in the direction of the long axis of the shaft: most of the lacunæ

are of the elongated form, and, as usual, those lying in the Haversian spaces partake more or less of the rounded figure; the former measure on an average $\frac{1}{800}$th of an inch in length, some of them even attaining to $\frac{1}{700}$th, whilst those of rounded figure vary from $\frac{1}{2000}$th to $\frac{1}{1500}$th of an inch in diameter.

B d 191. A transverse section of a metatarsal bone of an Antelope, *Antilope Euchore*, both outer and inner margins of which exhibit circumferential laminæ, the remaining portion being made up of Haversian systems of small size, in some of which the canal is divided transversely, in others obliquely, and in one spot in particular the course is in a series of curves, as in certain Birds; the lacunæ are very numerous, and their canaliculi are disposed with great regularity.

B d 192. A longitudinal section of the same bone, in which the canals run in the direction of the long axis of the bone, and are arranged in parallel rows. The lacunæ are mostly of the elongated kind, and measure on an average $\frac{1}{1000}$th of an inch in length and $\frac{1}{4000}$th in breadth. As in all the preceding specimens there are other lacunæ of rounded figure, averaging $\frac{1}{2000}$th of an inch in diameter.

B d 193. A transverse section of one of the digital phalanges of a Nylghau, *Antilope picta*; like the corresponding specimen of the Antelope, B d 191, both outer and inner margins exhibit circumferential laminæ, whilst the intermediate portions are made up of circular or elongated Haversian systems, according to the direction the canals take. The lacunæ and their canaliculi are both well displayed.

B d 194. A longitudinal section of the same bone, in which most of the canals run in the plane of the section, and they may be seen to give off transverse connecting branches; the laminæ in their neighbourhood are not very numerous, consequently the elongated lacunæ are not abundant, most of them being of the circular figure so often described as being present in the Haversian spaces; the former measure on an average $\frac{1}{1200}$th of an

inch, rarely attaining to the $\frac{1}{1000}$th, but the latter are seldom less than $\frac{1}{2000}$th of an inch in diameter; sometimes they are even as large as $\frac{1}{1500}$th.

B d 195. A transverse section of the humerus of a *Nylghau*, the outer edge of which is rough and irregular, and when examined microscopically is found to consist of very transparent bone with large irregular-shaped lacunæ with very few canaliculi, as in the bone upon which articular cartilage rests; the remainder of the section is made up of Haversian systems of different sizes, as in Preparation B d 193.

B d 196. A longitudinal section of the same bone, in which the canals are divided transversely, obliquely and longitudinally, and whatever may be the condition of the canal, the laminæ and lacunæ are disposed accordingly; but the most common condition is the arrangement in parallel lines, the greater number of the canals running longitudinally in the plane of the section. The bone is remarkably transparent, so that the lacunæ and their canaliculi are well displayed; the former measure on an average $\frac{1}{1200}$th of an inch, the longest rarely exceed $\frac{1}{1000}$th.

B d 197. A transverse section of a metatarsal bone of a Goat, *Capra Hircus*, both margins of which exhibit Haversian canals arranged in a series of curves, as before noticed in the Pig; the intermediate portion is made up of small Haversian systems: all the canals are of very small size, and the canaliculi are so numerous that no bone is visible between them.

B d 198. A longitudinal section of the same bone, in which the Haversian canals are arranged principally in parallel rows, and the laminæ and lacunæ follow the same course; the latter measure on an average $\frac{1}{1000}$th of an inch, and in some few cases even exceed $\frac{1}{800}$th; the canaliculi are so numerous as to render the section very opaque.

B d 199. A transverse section of the femur of a Sheep, *Ovis Aries*, which exhibits concentric laminæ both on its outer and inner margins, the remaining portion being made up of small closely-packed Haversian systems.

Amongst them may be seen Haversian spaces of various sizes, some of them being half filled up with new bone, which may be known by its being more opaque than the other parts of the section. A portion of this preparation, magnified 95 diameters, is represented in Plate XIV. fig. 5, and a few of the lacunæ, under a power of 440 diameters, in fig. 6.

B d 200. A longitudinal section of the same bone, in which most of the Haversian canals occur in parallel rows and have laminæ on each side of them, between which are lacunæ of elongated figure, those in other situations being more or less circular, and the bone very transparent. The elongated lacunæ measure $\frac{1}{800}$th of an inch in length and $\frac{1}{5000}$th in breadth; others are shorter and broader, being on an average $\frac{1}{1000}$th of an inch long and $\frac{1}{2000}$th broad, whilst the circular ones are $\frac{1}{1500}$th in diameter. A portion of this specimen, magnified 95 diameters, is represented in Plate XIV. fig. 7, and three of the oval lacunæ, under a power of 440 diameters, in fig. 8.

B d 201. A transverse section of the neck of the scapula of a *Sheep*, which has been mounted in Canada balsam, and every part well shown except the laminæ on the outer margin. The entire specimen is almost wholly made up of Haversian systems, some of which, from their opacity, appear to have been newly formed. The cancelli on the inner edge exhibit a laminated structure, the laminæ completely surrounding the cavities as they do the Haversian canals.

B d 202. A longitudinal section of the same bone, in which there are only a few canals, and these divided obliquely; the lacunæ are very abundant, and mostly arranged in parallel rows; they are of oval figure, and measure $\frac{1}{800}$th of an inch in the long by $\frac{1}{3000}$th in the short diameter. The canaliculi are very numerous, and give the bony matter a greyish hue.

B d 203. A transverse section of the femur of an Ox, *Bos Taurus*, which to the naked eye exhibits a laminated appearance, arising from the parallel arrangement of the Haversian canals in the plane of the section, similar

to that before noticed in the corresponding sections of the Pig and Ostrich. The canals are about $\frac{1}{150}$th of an inch distant from each other, and the laminæ are arranged parallel with them; throughout the entire section there are only a few instances in which concentric laminæ are seen surrounding a transversely divided canal. About midway between the canals a transparent line may be noticed; this forms the boundary of the several Haversian systems. A portion of this preparation, magnified 95 diameters, is represented in Plate XIV. fig. 1, and a few of the lacunæ, under a power of 440 diameters, in fig. 2; they in some instances exceed $\frac{1}{800}$th of an inch in length, and their canaliculi are so numerous that they give the bone a greyish tint.

B d 204. A longitudinal section of the same bone, which also exhibits a laminated appearance, arising from the parallel arrangement of those portions of the Haversian canals which in the preceding specimen were found to be divided transversely. The greater part of the lacunæ are disposed in parallel rows; the longest specimens measure $\frac{1}{800}$th of an inch, others average $\frac{1}{1000}$th in length and $\frac{1}{3000}$th in breadth; these occasionally exhibit their nuclei very plainly. A portion of this specimen, magnified 95 diameters, is represented in Plate XIV. fig. 3, and a few of the lacunæ, under a power of 440 diameters, in fig. 4.

B d 205. A transverse section of a portion of the scapula of an Ox, which has been mounted in Canada balsam; it exhibits numerous Haversian canals divided both transversely and obliquely, each having its corresponding arrangement of laminæ and lacunæ. One edge is very transparent, and in this part, certain oblique markings may be observed; these appear to be tubular, and no doubt are modified canaliculi. The length of the elongated lacunæ is $\frac{1}{800}$th of an inch.

B d 206. A longitudinal section of the same bone, also mounted in Canada balsam; the Haversian canals are divided both transversely and longitudinally; in the one case each is surrounded with concentric laminæ and lacunæ, in the other, both of the latter are parallel with the sides of

the canals. The lacunæ in the neighbourhood of the canals are all of the elongated form, whilst those more distant are circular.

B d 207. A transverse section of the zygoma of the *Sacred Ox* of the Egyptians, which exhibits all the peculiarities, in structure, of a corresponding section of a recent bone, with the addition of being coloured brown with bituminous matter; that part of the section nearest the name is so strongly impregnated as to appear quite black to the naked eye.

B d 208. A longitudinal section of the same bone, in which all the Haversian canals, and these are very numerous, are filled with bituminous matter, and their course and connecting branches rendered visible to the naked eye. The bone itself is of a yellow colour, and many of the lacunæ are of a darker tinge from containing bitumen; the canaliculi, as a general rule, are not very evident.

B d 209. A transverse section of the shaft of a long bone, probably the humerus of the *Ox*, which was found in New Zealand with a number of bones of various species of *Dinornis*: in its minute structure it agrees precisely with the transverse section of the humerus of an Ox. The Haversian canals are divided transversely, and each surrounded with laminæ and lacunæ both arranged concentrically: the Haversian spaces so common in the bones of the larger Ruminants are present in this preparation. A section from this same bone has already been described with the endo-skeleton of Birds, and forms Preparation B c 30; the bone in question having been imagined to belong to the *Dinornis*.

## Order Carnivora.

B d 210. A transverse section of the humerus of a Walrus, *Trichecus Rosmarus*; the inner margin presents a cancellated structure, the outer being comparatively free from canals; the concentric arrangement of the laminæ around the canals is only occasionally present; lacunæ disposed without much order, and so abundantly provided with canaliculi as to render the section opaque, occupy the greater part of the surface.

B d 211. A longitudinal section of the same bone, which is almost entirely made up of a cancellated structure: laminæ are very evident around some of the larger canals, and between them are elongated lacunæ provided with numerous canaliculi. In many of the spaces between the Haversian systems lacunæ of irregular figure occur, the bony matter between the canaliculi presenting a granular appearance, as in the larger Cetacea. The lacunæ are mostly of oval figure, and seldom attain the length of $\frac{1}{1000}$th of an inch.

B d 212. A transverse section of the tibia of a Seal, *Phoca vitulina*; to the naked eye the entire section appears to be made up of concentric laminæ, and this is owing to most of the Haversian canals being distributed in the plane of the section, as in the Ox and Pig before noticed. Very few of the canals are divided transversely, and those that are, seldom have more than three laminæ around them. The lacunæ in this specimen are remarkable for the great length of their canaliculi; those near the boundaries of the several Haversian systems form amongst themselves a coarse hexagonal network, with sometimes a trace of rounded spaces like those before noticed in the Pig, Preparation B d 163. This section, in some of its characters, agrees with that of the Sloth: a portion, magnified 95 diameters, is represented in Plate XIV. fig. 9, and under a power of 440 diameters, in fig. 10.

B d 213. A longitudinal section of the same bone, the centre of which is occupied by Haversian canals running the entire length of the section, but on the margins their course is at right angles, and they are consequently divided transversely: the lacunæ are principally arranged in parallel rows, and their canaliculi have an evident tendency to form a minute hexagonal network among themselves; the lacunæ seem seldom to exceed $\frac{1}{1000}$th of an inch in length. A portion of this preparation, magnified 95 diameters, is represented in Plate XIV. fig. 11, and as seen under a power of 440 diameters, in fig. 12.

B d 214. A transverse section of the humerus of a Seal, *Cystophora proboscidea*, the inner margin of which is almost wholly made up of cancellated tissue,

but the outer of dense bone; there is very little trace of laminated arrangement, the lacunæ being disposed in rows parallel with the larger cancelli.

B d 215. A longitudinal section of the same bone, in which both canals and lacunæ are very numerous and disposed in parallel rows; the latter are so abundant as completely to obscure all trace of laminæ; they seldom exceed the $\frac{1}{1000}$th of an inch in length; many of them exhibit traces of nuclei.

B d 216. A transverse section of the ulna of a Polar Bear, *Ursus maritimus*, which in its general characters precisely corresponds with the similar sections taken from other large mammalia. It is made up of a series of Haversian systems transversely divided, each one separated from its neighbours by a well-defined transparent boundary; many Haversian spaces are to be seen precisely agreeing with those found in the larger Ruminants.

B d 217. A longitudinal section of the same bone, in which the canals and laminæ can in some instances be traced from one extremity of the section to the other. The lacunæ are of two principal kinds; those occurring between the laminæ being all of elongated figure, and those in the interspaces, shorter and broader; the former measure $\frac{1}{800}$th of an inch in length, and the latter are the $\frac{1}{1000}$th in their long by $\frac{1}{3000}$th in their short diameter.

B d 218. A transverse section of a femur of a Bear, *Ursus Americanus*, which to the naked eye exhibits a laminated structure and upwards of sixteen Haversian spaces. The laminated structure is produced by broad concentric rows of lacunæ passing all round the section; these are separated by Haversian systems, in which the canal is divided transversely, and the laminæ and lacunæ disposed concentrically around them. The Haversian spaces sometimes exhibit the undulating margin, but, as a general rule, new laminæ have been deposited within them.

A portion of this specimen, showing a few of the Haversian systems,

is represented in Plate XIV. fig. 21, under a power of 95 diameters, and four of the lacunæ, under a power of 440 diameters, in fig. 22.

B d 219. A longitudinal section of the same bone, which to the naked eye exhibits a striated appearance, arising from the canals being arranged in the plane of the section; every canal has vertical laminæ on each side of it, with elongated lacunæ between them, and midway between any two canals are oval lacunæ and no trace of laminæ; these lacunæ correspond in position to the Haversian interspaces. A portion of this preparation, showing one canal and an Haversian interspace, is represented, under a power of 95 diameters, in Plate XIV. fig. 23, and three of the lacunæ, under a power of 440 diameters, in fig. 24; the elongated lacunæ measure $\frac{1}{900}$th of an inch on an average, but those situated in the Haversian interspaces seldom exceed $\frac{1}{1000}$th.

B d 220. A transverse section of the femur of the Raccoon, *Procyon lotor*; the greater part of the surface exhibits circumferential laminæ, these are separated by small Haversian systems; the lacunæ are chiefly divided in the direction of their long diameter, and the principal thing to be noticed in the section is the long and wavy condition of the canaliculi, in which it agrees with the corresponding sections of the Marsupialia. Between many of the canaliculi of the circumferential laminæ, small oval spots may be observed, each having a black dot or nucleus in its centre; they agree in size with those markings already noticed in the Pig and Seal; they measure about $\frac{1}{5000}$th of an inch in diameter.

B d 221. A longitudinal section of the same bone, in which the greater number of the canals are divided obliquely; the lacunæ are always at some considerable distance from each other, and their canaliculi in consequence are both long and wavy. The former measure on an average $\frac{1}{800}$th of an inch; the canaliculi in some parts exceed this in length: nuclei are to be seen in most of the lacunæ, but there is no visible trace of the nucleated bodies noticed in the transverse section.

B d 222. A transverse section of the femur of a Badger, *Meles taxus*, which

exhibits circumferential laminæ on both margins, especially on the inner one, the remainder of the specimen being made up of small Haversian systems, with three or four concentric circles of lacunæ around each; the lacunæ in these situations are of small size, but their canaliculi are very long and wavy.

B d 223. A longitudinal section of the same bone, in which the canals and lacunæ are both few in number and widely separated from each other, without any very evident trace of laminæ, except in those situations where the canals run in parallel lines. The lacunæ are of three principal kinds; the elongated, oval, and circular, the latter being the most common, and measuring on an average $\frac{1}{2000}$th of an inch in diameter; the elongated average $\frac{1}{800}$th of an inch in length; the oval $\frac{1}{1000}$th in the long by $\frac{1}{4000}$th in the short diameter.

B d 224. A transverse section of the humerus of the same *Badger*, which agrees in every respect with that of Preparation B d 222, except that the Haversian systems are of much larger size. The canaliculi are very long and wavy, especially those of the lacunæ occurring near the outer margin.

B d 225. A longitudinal section of the same bone, also agreeing in its minute structure with that of Preparation B d 223, except in being rather thicker and provided with a greater number of lacunæ and canaliculi; these last are so numerous in certain situations as to render the bone quite opaque.

B d 226. A transverse section of the femur of a Polecat, *Putorius Furo*; it is $\frac{1}{8}$th of an inch in diameter, but the bone itself is not more than $\frac{1}{40}$th of an inch broad; it is almost wholly made up of circumferential laminæ, except in some situations in the centre, where certain small Haversian systems occur; one of these is shown in Plate XIV. fig. 17, under a power of 95 diameters, and a few of the lacunæ, under a power of 440 diameters, in fig. 18.

B d 227. A longitudinal section of the same bone, in which many of the canals

are disposed in parallel lines, each having rows of laminæ and elongated lacunæ on either side of it; the other parts of the section have no laminæ, and the lacunæ are for the most part of rounded figure. A portion of this preparation, magnified 95 diameters, is represented in Plate XIV. fig. 19, and a few of the lacunæ, under a power of 440 diameters, in fig. 20; some of the elongated forms measure as much as $\frac{1}{700}$th of an inch, $\frac{1}{800}$th forms a good average; many of the circular ones exceed $\frac{1}{1300}$th of an inch in diameter.

B d 228. A transverse and a longitudinal section of the humerus of a *Polecat*; the former is almost wholly made up of concentric laminæ, except on one side, which is angular, and this exhibits a series of Haversian systems transversely divided. The lacunæ on the inner margin of this section are of considerable length, and their canaliculi long and wavy. In the latter, or longitudinal section, the canals and lacunæ are both disposed in parallel rows, and the lacunæ measure on an average $\frac{1}{800}$th of an inch.

B d 229. A transverse section of the femur of a Ferret, *Putorius Furo, var.*; it measures $\frac{1}{7}$th of an inch in diameter, and the breadth of the bony matter is $\frac{1}{40}$th of an inch. The entire section is made up of circumferential laminæ, and the Haversian canals are arranged in the plane of the section; these, as a general rule, intersect the laminæ at right angles. A few curved transparent lines are seen in the middle of the section, and these occur in the several Haversian interspaces: as in the corresponding section of the Polecat, the canaliculi are long and wavy.

B d 230. A longitudinal section of the same bone, the central portion of which exhibits only a few canals, and the lacunæ are all of rounded figure. The canals are seen near the edges, and elongated lacunæ are arranged in parallel rows between them: the rounded lacunæ measure on an average $\frac{1}{2000}$th of an inch in diameter, the elongated variety the $\frac{1}{1000}$th in length; some few are as long as $\frac{1}{800}$th, but these are rare.

B d 231. A transverse section of the humerus of an Otter, *Lutra vulgaris*; the

circumferential laminæ are very abundant both on the outer and inner margins, but on the edge nearest the number, where the section is broadest, numerous Haversian systems occur; the canals are divided obliquely, and very frequently the laminæ surrounding them are continuous with those of the inner margin: four well-marked Haversian spaces are present in this section.

B d 232. A transverse section of the femur of an *Otter*, in which both the canals and laminæ are arranged nearly on the same plane as that of the section itself, and it is only where the former are divided transversely that the several Haversian systems are distinctly marked out.

B d 233. A longitudinal section of the same bone, on one edge of which the bone is nearly opaque, and on the other cancellated; this last formed a part of the medullary cavity. In the opaque part, both canals and laminæ are arranged in parallel lines, whilst near the cancellated structure the canals are divided transversely, and the lacunæ disposed without much order. The canaliculi in all parts are exceedingly numerous, and when the bone has been ground so thin as to obscure the lacunæ, their divided extremities give to it a granular appearance. The longest of the lacunæ measure the $\frac{1}{900}$th of an inch; others measure $\frac{1}{1000}$th in their long by $\frac{1}{3000}$th in their short diameter. In the Haversian interspaces the bone is very transparent, and the lacunæ of irregular figure; their canaliculi are large and opaque, like those described on the outer margin of the femur of the Beaver, B d 45; many of them exceed $\frac{1}{1300}$th of an inch in diameter.

B d 234. A transverse section of the femur of an Ichneumon, *Mangusta Ichneumon*; like the corresponding section of the Polecat, it is made up of circumferential laminæ, crossed at right angles by Haversian canals. The edge opposite the number is broader than the rest, and in it may be seen a foramen for a blood-vessel; the lacunæ follow the course of the laminæ, and their canaliculi are long and wavy.

B d 235. A longitudinal section of the same bone, in which the Haversian

canals are of very small size, and disposed in the plane of the section: the lacunæ are principally of the elongated kind, measuring on an average $\frac{1}{1000}$th of an inch, some few being as much as $\frac{1}{800}$th.

B d 236. A transverse section of the humerus of a Mongoose, *Mangusta Mongos*, exhibiting numerous small Haversian canals, which take a wavy course all over the specimen, and laminæ accompany them. The lacunæ are of small size, and the canaliculi very numerous and exceedingly delicate.

B d 237. A longitudinal section of the same bone, in which both canals and laminæ are arranged in a series of curves; the lacunæ are principally of elongated figure, some of them measuring $\frac{1}{800}$th of an inch in length by $\frac{1}{8000}$th in breadth; others are the $\frac{1}{1000}$th in length by the $\frac{1}{5000}$th. The canaliculi from both kinds are very minute, but so numerous as to give the bony matter a granular appearance.

B d 238. A transverse section of the femur of a Fox, *Canis Vulpes*, which is made up of circumferential laminæ and of Haversian systems, the former being most evident on the side opposite the number, the latter on that nearest the name; the lacunæ are almost all of the elongated form, and their canaliculi very long, especially those situated between the circumferential laminæ.

B d 239. A longitudinal section of the same bone, in which the canals are very numerous, but from not running in the same plane as that of the section, they occur in so many short lengths. The lacunæ are abundant; those near the canals measure on an average $\frac{1}{1000}$th of an inch in length by $\frac{1}{4000}$th in breadth; and the others in the Haversian interspaces are the $\frac{1}{2000}$th of an inch in diameter.

B d 240. A transverse section of the radius of a Wolf, *Canis Lupus*, which is entirely made up of Haversian systems, except on its inner margin: the Haversian canals are of small size, and each surrounded with from

six to eight concentric laminæ. The lacunæ are of uniform size, and their canaliculi exceedingly numerous, and disposed with great regularity.

B d 241. A longitudinal section of the same bone, which to the naked eye exhibits a striated appearance, arising from the parallel distribution of the Haversian canals; these are accompanied with laminæ and lacunæ, and, midway between any two, a transparent line may be noticed, which corresponds to an Haversian interspace. The longest of the lacunæ measure the $\frac{1}{800}$th of an inch; the elongated are the $\frac{1}{1000}$th in the long diameter, by $\frac{1}{3000}$th in their short.

B d 242. A transverse section of a metatarsal bone of a large Dog, *Canis familiaris*; the section is $\frac{1}{2}$ an inch in diameter, and the breadth of the bony matter $\frac{1}{10}$th of an inch: except a very narrow band of circumferential laminæ, the whole section is made up of a series of circular Haversian systems, each separated from its neighbours by a well-defined transparent line. The number of lacunæ in each system is very small, but the canaliculi are very long and numerous.

B d 243. A longitudinal section of the same bone, in which the parallel distribution of the Haversian canals is readily seen with the naked eye. The laminæ and lacunæ are arranged in the usual manner; those near the canals are of elongated figure, the others either oval or circular: the first kind measure on an average $\frac{1}{1000}$th of an inch, some few are even as long as $\frac{1}{800}$th; and those of oval figure are $\frac{1}{1200}$th in their long diameter, and $\frac{1}{3000}$th in their short.

B d 244. A transverse section of the femur of another *Dog*, which is mounted in Canada balsam; it is made up of circumferential laminæ, between which numerous circular Haversian systems are intercalated: some of the Haversian systems are of large size, and surrounded by as many as ten concentric laminæ. The laminæ are of great breadth, and the canaliculi long in proportion. The inner edge of the section is very thin, and the course of the laminæ indicated by so many transparent lines.

B d 245. A longitudinal section of the same bone, also mounted in Canada balsam, which has penetrated every part, except some few of the lacunæ, these being filled with air. They are principally of the oval form, and measure on an average $\frac{1}{1200}$th of an inch in the long, by $\frac{1}{3500}$th in the short diameter.

B d 246. A transverse section of the tibia of a Hyæna, *Hyæna crocuta*; to the naked eye it presents two distinct kinds of structure, one on the circumference, occurring as a narrow band of concentric laminæ, the other, of laminæ disposed in a series of circles. The principal points to be observed in this section, are the small diameter of the canals, lacunæ, and canaliculi, and the great length of the latter.

B d 247. A longitudinal section of the same bone, in which the Haversian canals are of small size, and the laminæ everywhere plainly exhibited, except in the parts corresponding to the Haversian interspaces, which are not here transparent as in other bones, but present a more or less granular appearance. The lacunæ measure on an average $\frac{1}{1000}$th of an inch, very few being longer than the $\frac{1}{900}$th: their canaliculi frequently exceed $\frac{1}{1000}$th of an inch in length, and are so minute and so close together, that they give the section a transversely striated appearance. The specific gravity of the bone from which this and the preceding specimen were taken, was 2·144; this unusual density may be accounted for in some measure by the very small size of the canaliculi.

B d 248. A transverse section of the radius of a Lion, *Felis Leo*, which is made up of a series of broad laminæ, some surrounding the inner margin of the bone, others either continuous with them or arranged round the Haversian canals. The lacunæ are of large size, and their canaliculi very long and numerous. Another peculiarity in this section is the small size of the Haversian interspaces.

B d 249. A longitudinal section of the same radius, in which the laminated condition of the bone is more plainly seen than in any of the other Carnivora

which have preceded it; some of the laminæ are nearly $\frac{1}{2000}$th of an inch in breadth. The lacunæ are of two kinds, the elongated and the oval; in both the distribution of the canaliculi is well seen; in those of the oval kind, a delicate network is formed amongst themselves; the length of the elongated lacunæ is $\frac{1}{800}$th of an inch, whilst the oval ones measure $\frac{1}{1000}$th of an inch in their long diameter, and $\frac{1}{3000}$th in the short.

B d 250. A transverse section of the ulna of a *Lion*, which, like the corresponding specimen of the radius, is made up of a series of Haversian systems, the laminæ of which appear to be more or less blended with those of the circumference, the Haversian interspaces being exceedingly small. The laminæ surrounding the Haversian canals are very broad, which will account for the great length of the canaliculi.

B d 251. A longitudinal section of the same bone, in which there is a complete parallel arrangement of canals, laminæ and lacunæ; the latter exhibit nuclei very plainly, and the elongated variety, as a general rule, exceeds $\frac{1}{800}$th of an inch: the canaliculi are so numerous, that no trace of laminæ can be seen between them.

B d 252. A transverse section of the right ramus of the lower jaw of a *Lion*, which in its general characters agrees with a corresponding section of a long bone of the same animal, but with this difference, the Haversian interspaces being of large size, and occupied with lacunæ of peculiar figure, the canaliculi of which form amongst themselves a minute hexagonal network.

B d 253. A transverse section of the radius of a Tiger, *Felis Tigris*, the breadth of which in the centre exceeds $\frac{3}{8}$ths of an inch: it is entirely made up of a series of circular Haversian systems of various sizes, the boundary lines of which are not very well marked; the bone itself is in other respects peculiar; many of the Haversian interspaces, as well as portions of some of the systems, are quite transparent, exhibiting neither lacunæ nor canaliculi. A segment of this section, magnified 95 diameters, is

represented in Plate XIV. fig. 13, and a few of the lacunæ, under a power of 440 diameters, in fig. 14.

B d 254. A longitudinal section of the same bone, which is traversed in parallel lines by Haversian canals and laminæ ; the lacunæ are of the usual form, those between the laminæ being elongated, those in the parts corresponding to the Haversian interspaces shorter and broader, the former measuring $\frac{1}{800}$th of an inch, the latter seldom attaining $\frac{1}{1000}$th. A portion of this specimen, magnified 95 diameters, is represented in Plate XIV. fig. 15, and four of the lacunæ, under a power of 440 diameters, in fig. 16.

B d 255. A transverse section of the femur of a *Tiger*, which is made up entirely of Haversian systems of various sizes, but mostly of circular figure ; but the size of the canals varies considerably, some of them being as small as $\frac{1}{1330}$th of an inch, whilst others in the immediate neighbourhood exceed $\frac{1}{400}$th of an inch in diameter.

B d 256. A transverse section of the radius of a Jaguar, *Felis Onca*, which, like that of the Lion and Tiger before noticed, is made up of a series of small Haversian systems and of broad laminæ continuous with those of the inner margin of the section. On the side nearest the number, the Haversian systems are of very small size, and a great portion of each is made up of bone without any lacunæ or canaliculi. The laminæ are of considerable breadth, and the canaliculi long and delicate.

B d 257. A longitudinal section of the same bone, the greater part of which exhibits canals and laminæ divided in the direction of their long diameter. The lacunæ are of two principal kinds, the elongated and the oval, the one occurring between the laminæ, the other in the Haversian interspaces ; the canaliculi of the former are given off in parallel lines, whilst those of the latter are in the form of radii, and are much branched : the length of the elongated kind is $\frac{1}{800}$th of an inch, that of the oval $\frac{1}{1000}$th and $\frac{1}{3000}$th in breadth ; those of circular figure frequently exceed $\frac{1}{2000}$th in diameter.

B d 258. A transverse section of the femur of a Puma, *Felis concolor*, which is almost wholly made up of a series of circular Haversian systems of various sizes. The Haversian spaces are more numerous in this specimen than in any other of the Carnivora yet examined, and many of them afford evidence of the deposit of new bone on their internal surface. Several of the Haversian interspaces and a few of the systems themselves are very transparent, and although lacunæ are present their canaliculi are wanting.

B d 259. A longitudinal section of the same bone, in which most of the Haversian canals are divided obliquely, and each is surrounded by a series of oval laminæ; others have the laminæ almost entirely obscured by the great abundance of the canaliculi. The lacunæ are of the three usual kinds, the longest measuring $\frac{1}{800}$th of an inch, but the average is $\frac{1}{900}$th; the round ones average $\frac{1}{2000}$th of an inch in diameter.

B d 260. A transverse section of the tibia of a Cat, *Felis Catus*, both outer and inner margins of which, especially the former, exhibit circumferential laminæ, the intermediate portion being occupied with Haversian systems. In the outer circumferential laminæ many canals of small size are divided transversely, but these have no concentric arrangement of lacunæ around them; some of the canals pass across the laminæ obliquely and join those from the centre of the Haversian systems. On the inner margin of the section are one or two Haversian spaces, showing very clearly slight traces of the deposit of new bone. Some of the Haversian canals are of very small size, being less than $\frac{1}{2000}$th of an inch in diameter; the canaliculi are all very long and wavy.

B d 261. A longitudinal section of the same bone, in which the canals and lacunæ are disposed in the usual manner; the latter are all arranged in parallel rows, and their size is nearly uniform throughout, being on an average $\frac{1}{1000}$th of an inch in the long, by $\frac{1}{3000}$th in the short diameter.

B d 262. A transverse section of the femur of a *Cat*, which has been mounted

in Canada balsam, and although the greater part of the lacunæ and their canaliculi are filled with the balsam, it can be seen that the whole of the section is made up of Haversian systems, excepting the two bands of circumferential laminæ.

B d 263. A longitudinal section of the same bone, in which the Haversian canals are very few in number, and those that are present of very small size. The lacunæ are nearly all of oval figure, the majority being under $\frac{1}{1000}$th of an inch in length, but there are small groups occurring between the laminæ which are as long as $\frac{1}{800}$th of an inch.

## Order Quadrumana.

B d 264. A transverse section of the femur of a Flying Lemur, *Galeopithecus philippinensis*, which is $\frac{1}{8}$th of an inch in diameter, and the breadth of the bone $\frac{1}{50}$th of an inch; it is made up entirely of a series of small Haversian systems divided transversely, which resemble those of the Ornithorhynchus and Echidna in having the first row of lacunæ at a considerable distance from the Haversian canal; the canaliculi consequently are very long, but the boundaries of the Haversian systems are opaque, from the closeness of the lacunæ and their canaliculi in those positions.

B d 265. A longitudinal section of the same bone, in which the Haversian canals at the extremity nearest the name are divided in the direction of their length, but at the opposite one, more or less obliquely. The lacunæ are of three kinds, the elongated, the oval and the round, and are disposed in the usual manner; some of the first measure as much as $\frac{1}{600}$th of an inch in length and $\frac{1}{5000}$th in breadth; the second $\frac{1}{1000}$th in length and $\frac{1}{3000}$th in breadth; and the round $\frac{1}{1330}$th of an inch in diameter.

B d 266. A transverse section of the humerus of a Lemur, *Lemur tardigradus*, which, with the exception of a small portion of the inner margin, is made up entirely of a series of concentric laminæ and lacunæ; the former are very well seen on the periphery of the section.

B d 267. A longitudinal section of the same bone, in which there are only a few indications of canals, and these principally divided obliquely. The lacunæ are very numerous and mostly of oval figure; they measure on an average $\frac{1}{1000}$th of an inch in the long by $\frac{1}{4000}$th in the short diameter.

B d 268. A transverse section of the humerus of a Spider Monkey, *Ateles paniscus*, which exhibits circumferential laminæ both on its outer and inner margins, the remaining portion being made up of Haversian systems which differ from those of any specimen previously examined, in having the lacunæ of very small size, and the whole of the canaliculi from each arranged closely together; the canaliculi are very long, being in some cases three or four times the length of the lacunæ from which they are derived; the situations of some of the lacunæ are occupied by long straight canaliculi, from which branches are given off at right angles. A segment of this section is represented in Plate XVIII. fig. 1, under a power of 50 diameters, and in fig. 2, a portion under a power of 250.

B d 269. A longitudinal section of the same bone, in which the lacunæ are disposed in parallel rows; they are all of peculiar figure, and differ from any before described in having a prolongation from the extremity of the body of the cell, like one of the canaliculi, and from it other canaliculi are given off; many of the lacunæ have several of these branched canaliculi. The lacunæ are all very long and narrow; some of them measure as much as $\frac{1}{500}$th of an inch in length, exclusive of the prolonged portion above alluded to, and only $\frac{1}{5000}$th in breadth; there are very few lacunæ in the whole section which do not exceed $\frac{1}{800}$th of an inch in length; the canaliculi are all very long and numerous, not unfrequently being $\frac{1}{400}$th of an inch. A few of the peculiar lacunæ are represented in Plate XVIII. fig. 3, under a power of 440 diameters.

B d 270. A transverse section of the humerus of a Short-tailed Monkey, *Macacus Rhesus*; on the side nearest the name, the external portion of the section is made up of a series of Haversian canals, and the internal of circum-

ferential laminæ, but on the opposite side the laminæ are external, and the canals internal to them. The lacunæ and their canaliculi are disposed in the usual manner, but some few of the latter form by their ramifications oval spaces, each of which appears to enclose a cell containing one or two nuclei, like those previously described as occurring in the Pig and Peccari (Preparations B d 163 and 165). A portion of this specimen, magnified 95 diameters, is represented in Plate XIV. fig. 25, and a few of the lacunæ, under a power of 440 diameters, in fig. 26. Another portion, showing the peculiar cell-like markings and their nuclei, is represented in Plate XVIII. fig. 6, under a power of 250 diameters, and under a power of 440, in fig. 7.

B d 271. A longitudinal section of the same bone, in which both lacunæ and their canaliculi are well shown. The former are of three kinds, the elongated occurring between the laminæ, and exceeding $\frac{1}{600}$th of an inch in length; those of oval form, which average $\frac{1}{800}$th in length and $\frac{1}{3000}$th in breadth; and lastly, the circular, which not unfrequently measure $\frac{1}{1500}$th in diameter.

B d 272. A transverse section of the femur of an Entellus Monkey, *Semnopithecus Entellus*, which is made up principally of concentric laminæ, having a few intercalated Haversian systems. In all other respects the section precisely agrees with that of an ordinary mammalian bone.

B d 273. A longitudinal section of the same bone, in which the lacunæ are all of oval figure, and measure the $\frac{1}{800}$th of an inch in their long diameter, and $\frac{1}{3000}$th in the short.

B d 274. A transverse section of the radius of an Orang-utan, *Pithecus Satyrus*. With the exception of a few circumferential laminæ, it is entirely made up of Haversian systems of different sizes, the majority of which exhibit small lacunæ, having long delicate canaliculi; the rest are furnished with lacunæ and canaliculi of larger size. In some spots near the outer margin there are long tubes, like those previously described in the

Cetacea; they occur amongst the lacunæ, and are considered by Mr. Tomes as modified canaliculi; their direction is more or less oblique with respect to the laminæ. Many of the Haversian interspaces exhibit lacunæ of peculiar figure, and the bony matter between them is opaque and granular; even the most transparent parts present a granular character.

B d 275. A longitudinal section of the same bone, in which canals and lacunæ are arranged in parallel rows; the latter are of three principal forms: the elongated measure on an average $\frac{1}{800}$th of an inch in length, and $\frac{1}{5000}$th in breadth; the oval measure the $\frac{1}{1000}$th, by the $\frac{1}{3000}$th in breadth; and the rounded attain the $\frac{1}{2500}$th of an inch in diameter. In one spot there are a few lacunæ which measure as much as $\frac{1}{500}$th of an inch in length.

B d 276. A transverse section of the femur of an *Orang-utan*, which to the naked eye is of a yellow colour, from being more or less greasy. It is made up of a series of Haversian systems furnished with laminæ, some of which are very well marked, especially a few situated near the outer margin. The lacunæ, as a general rule, from being divided transversely, appear of small size, and their canaliculi are long and delicate; every here and there occur the oblique markings, supposed to be modified canaliculi, they are mixed up with opaque granular matter; all the bone presents more or less of this granular appearance. A portion of this section, magnified 95 diameters, is represented in Plate XIV. fig. 29; and a few of the lacunæ, exhibiting the great length of the canaliculi, are shown in fig. 30, under a power of 440 diameters.

B d 277. A longitudinal section of the same bone, in which the Haversian canals are very numerous and arranged in parallel rows; many of them are full of yellow material, which is probably oil. The canaliculi and most of the lacunæ are also filled with oil, and there are only a few spots in which both can be plainly seen; the lacunæ measure on an average $\frac{1}{800}$th of an inch; some of them approach to $\frac{1}{600}$th. A portion of this section, magnified 95 diameters, is represented in Plate XIV. fig. 31, and

a few of the longest lacunæ, under a power of 440 diameters, in fig. 32. The canaliculi are long and delicate.

B d 278. A transverse section of the radius of a Chimpanzee, *Troglodytes niger*, which, with the exception of a few circular laminæ on the inner margin, is entirely made up of a series of well-marked Haversian systems of various sizes, each separated from the other by a transparent line. This specimen agrees in some measure with that of corresponding sections of the *Orang-utan*, in having long and delicate canaliculi; but they are of larger diameter, and in this, approach more nearly to the human subject. A portion of this section is represented, under a power of 95 diameters, in Plate XIV. fig. 33, and a few of the lacunæ, from the margin of one of the Haversian systems, under a power of 440 diameters, in fig. 34.

B d 279. A longitudinal section of the same bone, in which the Haversian canals and laminæ are mostly arranged in parallel rows; the laminæ and lacunæ are very distinct, more so perhaps than those of any Mammalian bone yet described; the canaliculi are very delicate, and in some instances even exceed in length the lacunæ from which they are derived. The lacunæ are of three principal kinds: the elongated, occurring between the laminæ; the oval, and the round, which are situated in the Haversian interspaces; the former measure $\frac{1}{700}$th of an inch in length and $\frac{1}{4000}$th in breadth; the oval $\frac{1}{1000}$th in length and $\frac{1}{3000}$th in breadth; the circular $\frac{1}{2000}$th to $\frac{1}{1800}$th in diameter.

B d 280. A transverse section of the tibia of a *Chimpanzee*, which, like that of the radius, is made up of a series of Haversian systems, some being of large size, and exhibiting the laminæ very plainly, especially those which appear most transparent to the naked eye. The lacunæ and their canaliculi are of the same peculiar character as Preparation B d 278.

B d 281. A longitudinal section of the same bone, in which both canals and lacunæ are mostly divided in the direction of their short diameters, consequently the laminæ and the elongated lacunæ are rarely seen, the latter

being principally of oval figure; their canaliculi are very numerous; those near the canals are quite straight, but as a general rule the others are in the form of radii; both kinds are long and delicate, and this appears to be a character peculiar to the Quadrumana.

## Order Bimana.

B d 282. A vertical section of the anterior portion of the frontal bone of an adult Man, *Homo sapiens*; it consists of two plates of bone separated from each other by a cancellated structure; the broader plate has a convex margin, and formed part of the outer table of the skull; the narrower one, part of the inner table; this last, even to the naked eye, appears more dense than the former. When examined microscopically, both exhibit a well-marked laminated structure; in the outer table are numerous large Haversian canals having concentric laminæ around them; but in the inner one the canals are very few, and the laminæ continue from one extremity of the section to the other. The lacunæ occur between the laminæ, their canaliculi are long and numerous, and not so delicate as in the Quadrumana; they are remarkable for their frequent anastomosis.

B d 283. A similar preparation taken from another frontal bone; the only perceptible differences being, that the outer table is broader and more largely supplied with canals than that of the preceding specimen; when examined with a power of 200 diameters, that part of the outer table indicated by coloured lines exhibits a granular structure, the granules being those of the earthy matter. The long fibrous markings before described are also common in this part of the section. This specimen is represented of the natural size in Plate XV. fig. 9, and the portion indicated by the dotted lines, under a power of 200 diameters, in fig. 8.

B d 284. A vertical section of the left parietal bone of an adult *Human subject*, made parallel with the sagittal suture. The outer and inner table are

nearly of the same breadth, and are separated from each other by a well-marked diploë; the outer table and the diploë agree with a transverse section of a long bone, in exhibiting Haversian canals and lacunæ, whilst the inner corresponds with the medullary portion of the same section in being made up of circumferential laminæ only. In Plate XV. fig. 1, is shown a portion of this specimen, magnified 15 times; it includes the entire thickness of the section; in fig. 2 is shown a portion of the outer table, magnified 95 diameters, and in fig. 3, a corresponding part of the inner table under the same power. The lacunæ have very long canaliculi, as may be seen in fig. 4, under a power of 440 diameters, but they are not very numerous; the laminated condition of the bone, however, is very evident.

B d 285. A vertical section of the same parietal bone, made at right angles to that of the preceding specimen, or in other words, in a line with the coronal suture; it agrees in some respects with that section, but the distinction between the two tables is not quite so well marked. The lacunæ have long and delicate canaliculi, but they are not abundant, there being spots of considerable size without any trace of them; this is especially evident in the inner table.

B d 286. A vertical section of a parietal bone of an adult *Human subject*, made in a line with the sagittal suture, and mounted in Canada balsam. The tables are of about equal breadth and separated from each other by a diploë, the bony walls of which form a regular hexagonal network; it corresponds in structure precisely with that of Preparation B d 284, but in consequence of many of the lacunæ and canaliculi being filled with the balsam, the granular basis of the bone and the laminæ are more plainly exhibited.

B d 287. A vertical section of the petrous portion of the temporal bone of an adult *Human subject*, made at right angles to the auditory meatus; it presents two distinct kinds of structure, one in the thin curved lamina which formed part of the outer or cranial surface of the bone, the other

in the broad plate which was a portion of the bone surrounding the semicircular canals. The first is made up principally of circumferential laminæ, with lacunæ of the usual form; in the other the bone is very transparent, with the lacunæ and canaliculi more widely diffused; there are traces of laminæ, but these are only distinct around the Haversian canals; the latter are of small size and frequently divided transversely. Many of the lacunæ in this specimen are of the same shape as those occurring in the Haversian interspaces of the long bones.

B d 288. A vertical section of the petrous portion of the temporal bone of an adult *Human subject*, made in a plane horizontal with the base of the skull, and at right angles with that of the preceding specimen. The convex margin which formed part of the base of the cranial cavity exhibits well-marked laminæ and lacunæ of the usual form, but towards the opposite margin their character becomes altered; the lacunæ are very opaque, they are gathered together in groups and have few canaliculi; some even have no canaliculi at all; and there are large portions of the bone quite transparent, being devoid both of canals and lacunæ. In this particular, the section precisely agrees with the petro-tympanic bone of the larger Cetacea, Preparations B d 106 to 111; even the granular structure therein described is present in this specimen. Some of the lacunæ in the laminated portions are $\frac{1}{700}$th of an inch in length, and have long and delicate canaliculi, and many of them exhibit a large central nucleus.

B d 289. A vertical section of the body of the lower jaw of an adult *Human subject*, taken near the symphysis, which, like a transverse section of a long bone, is made up of a series of laminæ arranged around both outer and inner margins, the intermediate portion exhibiting Haversian canals divided transversely, each surrounded by a series of circular laminæ. The lacunæ and their canaliculi are both so very numerous, that none of the bony structure can be seen between them.

B d 290. A vertical section of the same jaw, taken in a plane parallel with the

coronoid process; it is somewhat in shape like the letter U, and exhibits a well-marked laminated structure, the laminæ following the course of the canals. The lacunæ are of the usual figure, and their canaliculi very numerous.

B d 291. A horizontal section of the same jaw, taken across the coronoid process; like the preceding specimen it corresponds very nearly with a transverse section of a long bone, the laminæ being particularly well marked. The canaliculi of the lacunæ nearest the name are very long and delicate.

B d 292. A thin unground portion of the ethmoid bone of the *Human subject*; it is composed of transparent bone, in which there are lacunæ of various forms arranged without much order; many of them are of circular figure with large radiating canaliculi, others are oval with very long canaliculi; the first kind measure $\frac{1}{1330}$th of an inch in diameter; the oval $\frac{1}{800}$th of an inch in their long, and $\frac{1}{3000}$th in their short diameter.

B d 293. A transverse section of the body of a cervical vertebra of an adult *Human subject*, which is composed principally of cancellated structure; the more solid portion formed the outer surface of the vertebra, the cancellated being situated in the interior. When examined with a power of 100 diameters, laminæ and lacunæ occur in every part, but the bone is not so transparent, being more granular than that found in the several sections which have preceded it.

B d 294. A vertical section of the body of the same vertebra, in which a structure similar to that of the preceding specimen is plainly shown; the bone is more transparent and less granular, but the laminæ and lacunæ are both very well marked; the latter are of the forms usually seen in longitudinal sections.

B d 295. A transverse section of the spinous process of a dorsal vertebra of an adult *Human subject*, which precisely corresponds with a similar section

of a long bone; the lacunæ appear of small size, but their canaliculi are very long and frequently anastomose; all those parts of the section not supplied with lacunæ exhibit a granular structure.

B d 296. A transverse section of a rib of an adult *Human subject*; it is of an elongated oval figure, the sides being composed of dense bone, and the centre of a delicate cancellated structure. It corresponds in structure with a transverse section of a long bone, and exhibits numerous Haversian canals with laminæ and lacunæ around them; the latter are well supplied with canaliculi, which frequently anastomose. All parts of the section not occupied with lacunæ exhibit a granular structure. This specimen is represented of its natural size in Plate XV. fig. 6; a portion, as seen under a power of 95 diameters, is shown in fig. 5; and a few of the lacunæ, with very long canaliculi, under a power of 440 diameters, in fig. 7.

B d 297. A transverse section of the axillary border of the left scapula of an adult *Human subject*, which agrees in every particular with a transverse section of a long bone; circumferential laminæ occur on both margins, all the other portions being occupied with Haversian systems of various sizes.

B d 298. A transverse section of the acromion process of the same scapula; it is almost wholly made up of cancellated tissue; the margin which formed the outer surface of this bony process is merely a thin shell, but both it and the other parts exhibit the usual characteristic laminæ and lacunæ.

B d 299. A transverse section of the coracoid process of the same scapula, which consists of a thin ring of bone, almost wholly composed of cancellated tissue, but its minute structure agrees with that of a transverse section of a long bone.

B d 300. A portion of the dorsum of the scapula of an adult *Human subject*, which is sufficiently thin to be examined without being ground. Like

all corresponding thin plates of bone, it exhibits great numbers of lacunæ of rounded or of irregular form, all of which are provided with radiating canaliculi; the bone between the canaliculi presents a granular appearance.

B d 301. A transverse section of the clavicle of an adult *Human subject*, which is composed of a thick wall of bone surrounding a cancellated interior. Circumferential laminæ occur both on the outer and inner margins, the intermediate portion being made up of Haversian systems of various sizes. A portion of this preparation, magnified 95 diameters, is represented in Plate XVII. fig. 1; the Haversian systems are separated from each other by a transparent line or band, and most of the canaliculi, it will be noticed, are given off from the sides of the lacunæ nearest the Haversian canal; in the outer row all are given off from one side, and the transparent band is the result.

B d 302. A longitudinal section of the same bone, in which the Haversian canals are arranged in parallel rows, with occasional transverse connecting branches, as shown in Plate XVII. fig. 2, under a power of 95 diameters; two kinds of lacunæ are present, the elongated on the margins of the canals, and the oval external to them. Both are well represented in the figure.

B d 303. A transverse section of the humerus of an adult *Human subject*, exhibiting circumferential laminæ on both margins, the intermediate portion being occupied with Haversian systems of various sizes, in some of which the concentric laminæ are most strongly marked. This section precisely agrees with that of the long bones of all the larger mammalia, the principal difference being the shape of the lacunæ. Every portion of the bony matter exhibits a minutely granular appearance.

B d 304. A longitudinal section of the same bone, in which nearly all the Haversian canals are divided in the direction of their length, and there is the usual disposition of laminated and non-laminated bone between them, the lacunæ in the former being more or less elongated, but in the latter oval or rounded; the one measuring $\frac{1}{700}$th of an inch in length,

occasionally $\frac{1}{650}$th; the oval $\frac{1}{1000}$th in the long by $\frac{1}{4000}$th in the short diameter, the round averaging $\frac{1}{2000}$th of an inch in diameter.

B d 305. A transverse section of the radius of the same *Human subject*, taken from the middle of the shaft; in its minute structure it precisely agrees with the corresponding section of the humerus, and there are many of the Haversian systems which, from the fact of their exhibiting the concentric laminæ so plainly, would appear to have been Haversian spaces newly filled up.

B d 306. A longitudinal section of the same bone, which also agrees in its minute structure with that of the longitudinal section of the humerus, but is rather thinner, so that the laminæ and the different kinds of lacunæ are more plainly seen.

B d 307. A transverse section of the ulna of the same *Human subject*; it is a thicker bone than the radius, but exhibits precisely the same characters. Many of the Haversian systems afford evidence of the deposit of new bone in their interior, and on the side nearest the number there is a spot in which nearly every system has a greater or less space without either lacunæ or canaliculi, but the bone is distinctly granular.

B d 308. A longitudinal section of the same bone, in which the canals, the laminæ and the lacunæ are all arranged in the usual manner; the peculiar lacunæ occurring in the Haversian interspaces are particularly well seen in this section.

B d 309. Two vertical sections of the olecranon process of the ulna of an adult *Human subject*, both of which are made up principally of cancellated tissue. The larger specimen, having a concave articular surface, is represented of its natural size in Plate XV. fig. 12; and a portion of it, as seen under a power of 200 diameters, in fig. 11: all that part upon which the articular cartilage is seated is made up of transparent bony matter, in which are large opaque irregular-shaped lacunæ, as shown at *a*; some of them exhibit traces of canaliculi, others are full of granular matter; the

same kind of granular material occurs also in the bony matrix in which the lacunæ are imbedded, as represented at *b*. The remainder of the section, like that shown at *c*, exhibits lacunæ of the ordinary form, but from the specimen having been mounted in Canada balsam, they are rendered transparent. The transparent bone containing the peculiar lacunæ above described, forms the *articular lamella* of Mr. Toynbee.

B d 310. A vertical section of the trapezoid bone of the wrist of an adult *Human subject*, which is made up entirely of cancellated tissue, except the margins, all four of which are coated with a thin layer of the peculiar transparent bone described in the preceding specimen; the remaining portions of bone exhibiting lacunæ of the usual form, but most of them being filled with Canada balsam. A segment of this section is represented in Plate XV. fig. 10, as seen under a power of 200 diameters.

B d 311. A transverse section of a metacarpal bone of an adult *Human subject*, which agrees precisely in its minute characters with those of the corresponding sections of all the human long bones previously described. It is entirely made up of Haversian systems of different sizes, some exhibiting the concentric laminæ very plainly, others little or no trace of them, but all showing the lacunæ and their canaliculi very plainly.

B d 312. A longitudinal section of an ungual phalanx of an adult *Human subject*, both extremities of which exhibit a cancellated structure, the intermediate portion being more solid. The large or articular extremity is coated with a layer of the peculiar transparent bone before described, but all the remainder agrees with a corresponding section of a long bone in exhibiting canals and lacunæ arranged in parallel rows.

B d 313. A vertical section of the os ilium of an adult *Human subject*, consisting of two layers of compact bone separated by a cancellated structure; it agrees precisely with a transverse section of a long bone in exhibiting Haversian canals surrounded with well-marked concentric laminæ; the

principal difference between this section and one of a long bone is that the bony matter is much more granular.

B d 314. A vertical section of the ramus of the os ischium of the same *Human subject*; like the ilium the section is composed of a ring of solid bone enclosing a cancellated tissue, but only a portion of the ring is preserved. In its minute structure it precisely agrees with a transverse section of a long bone, being made up of a series of Haversian systems, each surrounded with a concentric arrangement of laminæ and lacunæ, but the bone itself is very granular.

B d 315. A vertical section of the body of the os pubis of the same *Human subject*, which corresponds in its general characters with that of the preceding preparation, but only a portion of the ring of bone is preserved, and this agrees in its minute structure with a longitudinal rather than with a transverse section of a long bone, many of the canals and laminæ being disposed in parallel rows; the bony matter in some parts is very opaque and granular.

B d 316. A transverse section of the femur of an adult *Human subject*, which is wholly made up of Haversian systems of various sizes, there being hardly any trace of circumferential laminæ on either margin. A few Haversian spaces are present, some of which have been nearly filled up with new deposit, and may be at once known by their undulating margin; in other respects the section precisely agrees with that of the bones of the arm and fore-arm.

B d 317. A transverse section of the same bone, in which there are traces of circumferential laminæ on both margins, and several Haversian spaces and large canals on the inner one; in other respects the section precisely agrees with that of the preceding specimen. A portion, magnified 20 diameters, is represented in Plate XVI. fig. 1; the circumferential laminæ of the outer surface are shown at *a*; a few of the Haversian systems, magnified 95 diameters, are represented in fig. 2.

B d 318. A longitudinal section of the same bone, which has been mounted in Canada balsam; all parts are clearly displayed; the canals run in parallel lines, and on either side of them may be seen the laminæ with the elongated lacunæ, and more external, the oval and rounded lacunæ occurring in the non-laminated bone. The walls of the canals are plainly seen; some of them present a granular appearance, arising from the openings of the numerous canaliculi: the length of the elongated lacunæ is sometimes as much as $\frac{1}{800}$th of an inch. A portion of this specimen, to show the canals, as seen under a power of 20 diameters, is represented in Plate XVI. fig. 3; and a portion of the same, under a power of 95 diameters, in fig. 4: a smaller portion is represented in fig. 6, under a power of 440 diameters; and at *a* is shown an Haversian canal divided vertically; the dots are the openings of the canaliculi. In fig. 5 are represented three of the oval lacunæ, magnified 1200 diameters; the bony matter is very granular.

B d 319. A transverse section of the tibia of an adult *Human subject*, which exhibits circumferential laminæ on its inner, but none on its outer margin, the remainder of the section being made up of Haversian systems of various sizes; the only peculiarity to be observed being the large size of the spaces between the several systems, many of which are either without lacunæ, or the lacunæ are without canaliculi.

B d 320. A longitudinal section of the same tibia, in which the Haversian canals are few in number, but they all run in parallel rows, and each is accompanied with the corresponding arrangement of laminæ and lacunæ so common in sections of this kind. The three forms of lacunæ, as well as the laminæ, are seen to great advantage, and all the former are well provided with canaliculi.

B d 321. A transverse section of a fibula of an adult *Human subject*, taken from the centre of the shaft; its margins are angular, and on the side nearest the name may be noticed several Haversian spaces, some of which have been wholly, others partially, filled up with new bone. The Haversian

systems are of large size, and many of them have been cut obliquely, and the number of laminæ on one side of the canal is considerably greater than that on the opposite; in other respects the section agrees with the corresponding one of the femur and tibia.

B d 322. A longitudinal section of the same bone, in which the canals and lacunæ are disposed in the usual manner; the laminæ are very well seen, and many of the lacunæ between them measure as much as $\frac{1}{800}$th of an inch in length, although the average is rather above $\frac{1}{1000}$th.

B d 323. A vertical section of one of the cuboid bones of the tarsus of an adult *Human subject*; like the bone of the carpus already described, it is made up of cancellated tissue, except on the margin, where there is a layer of bone, upon which the transparent articular lamella containing large opaque and peculiar-shaped lacunæ is situated. The structure of the articular lamella agrees with that of the trapezoid bone represented in Plate XV. fig. 10.

B d 324. A transverse section of the metatarsal bone of the middle toe of an adult *Human subject*, which, like the shaft of a long bone, exhibits a medullary cavity of considerable diameter. It is made up principally of Haversian systems of various sizes, each having its concentric arrangement of laminæ and lacunæ around it, but neither the lacunæ nor the bone substance are so well defined as in the corresponding sections of the other long bones of the extremity; the lacunæ are very opaque, especially those in the Haversian interspaces, and the bone itself is dark and very granular.

B d 325. A longitudinal section of the same bone, in which the canals are of large size; most of them have well-marked laminæ on each side, with the usual accompaniment of elongated lacunæ. At the extremity nearest the number the lacunæ are of very irregular figure, and the bony matter between them opaque and granular.

B d 326. A transverse section of the ungual phalanx of the great toe of an adult

*Human subject*, which is a thin ring of bone principally composed of cancellated tissue. All the thicker parts exhibit Haversian systems of various sizes, but the lacunæ are mostly of irregular figure, and the bony matter opaque and granular, as in the sections of the metatarsal bone previously described.

B d 327. A longitudinal section of the same bone, in which both extremities are preserved; the articular one is the broadest, and immediately above it is a triangular portion made up of cancellated tissue, the remainder of the section being more or less solid. The articular lamella with its peculiar lacunæ is plainly seen; the other portions of the specimen agree with a corresponding section of a long bone; it will be noticed that near the distal extremity, the peculiarity in the shape of the lacunæ and the granular condition of the bony matter, which have been spoken of in the three last-described Preparations, exist here also.

B d 328. A transverse section of the right patella of an adult *Human subject*, which is made up entirely of cancellated tissue; it agrees with a corresponding section of a long bone, and all the broader portions exhibit Haversian canals with laminæ and lacunæ around them. The extremity nearest the number is partly invested with the articular lamella, in which the characteristic lacunæ may be observed.

B d 329. A longitudinal section of the same bone, in which the laminæ and lacunæ are only imperfectly shown, in consequence of the great abundance of the granules of earthy matter; another peculiarity to be noticed is the small number of the lacunæ in some of the Haversian interspaces. The granular condition of the bone is most evident at the extremity nearest the name.

B d 330. A vertical section of a sesamoid bone from the great toe of an adult *Human subject*, which is made up wholly of cancellated tissue, exhibiting the ordinary arrangement of laminæ and lacunæ imbedded in an opaque granular matrix. The articular surface is at once known by its lamella,

which consists of very transparent bone enclosing the large irregular-shaped lacunæ before described.

B d 331. A few filaments of bone obtained from the medullary cavity of the femur of an adult *Human subject*; they are of a brown colour, and although not more than $\frac{1}{400}$th of an inch in diameter on the average, they exhibit laminæ and lacunæ, and the broader portions sometimes have an Haversian canal in the centre.

a. *Endo-skeleton of Human fœtus.*

B d 332. Two portions of the thin edge of the right parietal bone of a *Human fœtus* at the fourth month of utero-gestation, both of which are mounted in Canada balsam. The bone is in the form of thin spicula, so connected together by cross branches that a cancellated tissue is produced, in and between which are channels for blood-vessels. The thinnest portions of bone are without lacunæ, but all the thicker ones are abundantly provided with them; they are of oval figure, and measure on an average $\frac{1}{1000}$th of an inch in the long and $\frac{1}{3000}$th in the short diameter.

B d 333. A transverse section of the femur of a *Human fœtus* at the seventh month of utero-gestation; it is mounted in Canada balsam, and exhibits Haversian canals arranged in two ways; one in the plane of the section, and the other at right angles to it, as in the Pig and Ox before described. The lacunæ are not very abundant near the canals, but at a little distance they are so numerous and the bony matter between them so granular, that these parts of the section are opaque. The canaliculi in some situations are nearly as well exhibited as in the bone of an adult.

B d 334. A transverse section of a tibia of a *Human fœtus* at the seventh month of utero-gestation, taken from the centre of the shaft; the breadth of the bone is much greater than that of the femur, and it is almost wholly made up of Haversian systems of various sizes, each of which is bounded by a row of opaque lacunæ. On the side of the section nearest the number, the Haversian canals are of small size and divided transversely,

but on the opposite many of them are of larger size and divided obliquely. All the lacunæ are provided with canaliculi, but the bone between them is in some situations dark and granular.

B d 335. A transverse section of the femur of a *Human fœtus* at the period of birth, which differs from that of the fœtus of seven months (Preparation B d 333), in having the Haversian systems of larger size, and the lacunæ and their canaliculi more distinct from each other. The bone is in too granular a condition for the laminæ to be distinctly seen.

B d 336. A longitudinal section of the same bone, in which the Haversian canals and lacunæ are arranged in parallel rows, but the rows of the latter are generally not more than two or three in number; these lacunæ and their canaliculi are well developed, but all those occurring in the parts corresponding to the Haversian interspaces are of large size and irregular figure, and very few of them exhibit canaliculi. The bone everywhere exhibits a granular appearance, so much so, that no trace of laminæ can be distinctly made out; the elongated lacunæ near the canals measure $\frac{1}{1000}$th of an inch in length and $\frac{1}{4000}$th in breadth; the irregular ones are sometimes $\frac{1}{800}$th in length and $\frac{1}{1500}$th in breadth.

B d 337. A transverse section of the femur of another *Human fœtus* at the period of birth, which consists of a thin ring of bone, having its internal or medullary margin made up of cancellated tissue. The general arrangement of the canals and lacunæ somewhat resembles that of Preparation B d 336, but their canaliculi are much more distinct, and the bone itself more transparent and less granular; some of the canaliculi are of great length.

B d 338. A longitudinal section of the same bone, in which the Haversian canals are very numerous and arranged in the plane of the section, but there is very little indication either of laminæ or elongated lacunæ; the principal feature in the section is the presence of oblique granular markings like those previously described in the bones of the larger Cetacea; many of them have the appearance of modified lacunæ.

b. *Bones having their lacunæ and canaliculi filled with foreign matter.*

B d 339. A transverse section of the femur of an adult *Human subject*, which was found imbedded in black mud about 12 feet below the surface of the ground. It has been boiled for some time in Canada balsam, in order to fill the lacunæ and their canaliculi, and render them transparent. On a careful examination it will be noticed, that many of the Haversian canals are occupied with a black substance, and that some of the lacunæ and their canaliculi are more opaque and more plainly seen than usual; this is due to their being filled with earthy matter taken up from the Haversian canals, and by the anastomosis of the several canaliculi conveyed in some instances even to the outermost row of lacunæ. A portion of this preparation, magnified 95 diameters, is represented in Plate XV. fig. 13, and the lacunæ and canaliculi there shown as being very opaque are filled with earthy matter.

B d 340. A transverse section of the same bone, which has been ground exceedingly thin before being boiled in the Canada balsam. Many of the Haversian canals are surrounded with concentric circles of lacunæ having their canaliculi filled with black matter, no other canaliculi being visible; the bony matter of several of the Haversian systems is of a brown colour.

B d 341. A longitudinal section of the same bone, the Haversian canals of which run in parallel lines; many of them contain black matter, and the elongated lacunæ in their neighbourhood are also filled with it: there are other lacunæ in this specimen which are well displayed, but those which have been filled with the earthy matter may be at once recognized by the blackness of their canaliculi.

B d 342. A similar preparation in which the canals and lacunæ that have been filled with black matter are more plainly seen than those in any of the preceding specimens. The section is of a brown colour, but it will be noticed that the bone in the neighbourhood of some of the canals is of a

darker brown than the rest; when these parts are divided transversely, they form the Haversian systems spoken of in Preparation B d 340.

B d 343. A longitudinal section of the cannon bone of a fossil *Horse* from the Himalayas, which has been ground very thin; when viewed with the naked eye, numerous markings of a brown colour are visible; these when viewed with a power of 250 diameters, will be found to be made up of Haversian canals and lacunæ filled with a brown colouring matter. A portion of this specimen is represented in Plate XV. fig. 19.

B d 344. A transverse section of the femur of an Egyptian mummy of a *Child* about 2 years of age; the internal margin is cancellated and the entire section is of a brown colour; when viewed with a power of 250 diameters, all the Haversian canals and most of the lacunæ are filled with brown colouring matter.

B d 345. A longitudinal section of the same bone, which is of a light brown colour; the lacunæ are well displayed in certain situations, but most of those in the centre of the specimen have their canaliculi indistinctly seen. Many of the lacunæ present the usual opaque appearance; others, it will be noticed, are full of a brown-coloured material.

B d 346. A transverse section of the femur of an Egyptian mummy of a *Child* about 12 years of age; it is of a rich brown colour. When examined with a power of 95 diameters, it will be found to be made up of a series of Haversian systems, most of which have an opaque margin, the other portion being transparent and of a brown colour. Many Haversian spaces may be noticed at the extremity nearest the number.

B d 347. A transverse section of the femur of an Egyptian mummy of an adult *Human subject*, which is made up of a series of Haversian systems of various sizes, each being surrounded with a broad transparent line or band of uniform thickness. Most of the Haversian systems are of an opaque brown colour, but occasionally one may be seen which is perfectly transparent. A portion of this specimen, magnified 95 diameters,

is represented in Plate XV. fig. 16 ; the transparent Haversian system is shown at *a* ; the canals are full of bituminous matter.

c. *Human bones impregnated with earthy material in a crystalline form.*

B d 348. A transverse section of a femur of an adult *Human subject*, found in travertine, near Santa, in Peru, in which nearly all traces of lacunæ and canaliculi have been destroyed and their places occupied by transparent crystals of various sizes ; the crystals also occur in the Haversian canals, and in these situations they are best seen. A portion of this specimen, magnified 120 diameters, is represented in Plate XVIII. fig. 8.

B d 349. A transverse section of the same bone, which has been made thinner than the last in order to display the crystals more plainly ; when this specimen is viewed under polarized light, the laminæ are most plainly seen, but by ordinary light they can hardly be detected ; the crystals in the Haversian canals are all very brilliantly coloured when viewed by the polariscope. A portion of this specimen, as seen under a power of 120 diameters, is represented in Plate XVIII. fig. 9.

B d 350. A longitudinal section of the same bone, in which may be noticed many dark branching lines, such as generally occur in bones which have undergone a certain amount of decay. The Haversian canals are filled with crystalline material, but no very decided specimens can be seen amongst the laminæ as shown by the transverse sections.

d. *Bones of animals which have been fed on madder.*

The colouring matter of Madder, *Rubia tinctorum*, has a great affinity for phosphate of lime, with which it forms an insoluble compound. The colouring principle is sparingly soluble in water, but is readily so in the serum of blood ; by feeding an animal on madder, the colouring matter is taken into the circulation and held in solution by the serum, and when carried to the bones all the newly-developed portions will immediately combine with it, and a rich colour will be produced ; by leaving off the madder, colourless phosphate of lime will again be deposited ; and if the madder be again employed, the colouring of the

phosphate will take place accordingly. The action of madder on growing bones was first noticed by Mr. Belchier in 1736; experiments were performed on this subject by Mr. Hunter, and many specimens of the bones of the Pig which have been coloured by this material will be found in the Physiological series in the Museum; from one of these, Preparation B d 357 is taken. When examined microscopically, not only will the outer and inner margins of a transverse section be coloured, but the bone in immediate contact with the walls of the Haversian canals also; this is well shown in Preparation B d 353.

B d 351. A transverse section of the tibia of a young *Pig* which had been fed upon madder; the bone composing the outer margin of the section is tinged with madder, and its colour is that of a rich lake; most of the Haversian canals contain blood-vessels, and many of these are filled with the colouring matter of the madder, as shown in Plate XVI. fig. 10.

B d 352. A transverse section of the tibia of another young *Pig*, the outer margin of which is richly tinged with the colouring matter of madder; the blood-vessels contained within the Haversian canals are full of a red colouring matter, some of which has tinged the bone surrounding them.

B d 353. A transverse section taken from the upper extremity of the tibia of a *Pig* fed on madder, in which very little colouring of the bone can be seen on the outer and inner margins, but it has all followed the course of the Haversian canals.

B d 354. A transverse section of the inferior extremity of the same tibia, in which the inner margin of the section is more deeply tinged with colour than the outer; most of the Haversian canals also have their blood-vessels full of colouring matter.

B d 355. A transverse section of the tibia of another *Pig*, also fed on madder, taken from the distal extremity: there is nearly a complete ring of colourless bone external to that tinged with madder, showing that the feeding with madder had been discontinued prior to the death of the animal.

B d 356. A transverse section of the inferior portion of the upper third of the tibia of a very young *Pig* which has also been fed on madder; the Haversian canals are of large size and most of them are filled with a rich pink colour, some of which has tinged the bony matter in the neighbourhood.

B d 357. A vertical section of the tibia of a young *Pig* which was fed on madder, upwards of 70 years ago; very little of the colouring matter now remains, but still enough to show that the bone in the neighbourhood of the canals was once tinged with pink.

e. *Deciduous appendages to the frontal bones of Ruminants termed Antlers.*

In many genera of the order Ruminantia, certain bony processes termed *horns* or *antlers* are developed from the tuberosities of the frontal bones; these, although strictly belonging to the endo-skeleton, were omitted to be described with the bones of the animals to which they belonged: in the Oxen, Sheep, Goats, and Antelopes, they extend outwards either in a straight or curved direction, and form permanent processes named *cores*, and are covered with a thick layer of non-vascular material known as *horn*. In the Deer tribe the growths from the bony tuberosities are termed *antlers*; they are branched processes composed of highly organized bone, agreeing in structure with that of most bones of the body of the same animal, in having a compact exterior and a cancellated interior; they are deciduous, the point of separation being the tuberosity at the base, termed the *burr*. When fully developed, antlers have no coating of vascular or non-vascular substance, although a layer of the former, termed *velvet*, completely covered them and supplied them with nourishment during their growth.

B d 358. A transverse section of the antler of a Fallow Deer, *Cervus Dama*: at first sight it will be found to resemble a corresponding section of a long bone of the same animal, in having a dense exterior and a cancellated interior; the former exhibits an immense number of small Haversian canals, each of which is surrounded with three or four laminæ; the diameter of the canals is $\frac{1}{1000}$th of an inch; in the cancellated portion they are of much larger size, and it is by no means uncommon to find one canal in some part of an Haversian system, but without any con-

centric arrangement of laminæ around it; sometimes two canals occur so close together that an isthmus of bone not more than $\frac{1}{1500}$th of an inch separates them. The lacunæ and their canaliculi precisely correspond in size with those of the transverse section of the long bone of the same animal; many of the Haversian canals are filled with blood.

B d 359. A transverse section of the outer surface of the antler of the same *Fallow Deer*, which has little or no trace of cancellated tissue; but some of the Haversian canals towards the centre are larger than usual. The outer margin is very transparent and the lacunæ few in number, but the Haversian canals may still be noticed to contain blood.

B d 360. A transverse section of the burr of an antler of a young *Fallow Deer*, exhibiting four large foramina for the passage of blood-vessels; the other portions of the bone are very compact. The Haversian canals are principally divided obliquely, and the Haversian systems in consequence are of elongated figure. On the outer margin, which corresponds to the burr, the bone is very transparent; the lacunæ few in number, and most of them without canaliculi. A portion of this specimen, magnified 50 diameters, to show this peculiar structure, is represented in Plate XVIII. fig. 13; and another portion, under a power of 250 diameters, showing an Haversian canal surrounded by transparent bone, in fig. 14.

B d 361. A transverse section of the base of the antler of another *Fallow Deer* taken through the burr; there are four foramina for the passage of large vessels. The internal margin presents a cancellated structure, but the outer one is made up of very transparent bone, in which the Haversian canals are exceedingly small, and little remains of the lacunæ and canaliculi.

B d 362. A vertical section of the base of the antler of another and larger *Fallow Deer*, in which there are foramina for blood-vessels, and the same kind of structureless bone on the part corresponding to the burr, as that described in the three preceding specimens; this seems to be a constant character in other parts of the section; the canals, lacunæ and canaliculi are of the usual figure.

B d 363. A transverse section of the base of an antler of a small Deer, *Cervus porcinus*, which was still attached to the skull. One large foramen occurs near the outer margin, and the same transparent bone occurs near to it, this part corresponding with the burr. All the other portions are made up of ordinary bone with well-marked lacunæ and canaliculi.

B d 364. A transverse section of the antler of the gigantic Irish Deer, *Megaceros Hibernicus*, exhibiting a solid exterior and a cancellated interior; the structure of the former is precisely like that of a long bone of the same animal, but the Haversian canals are smaller; lacunæ and their canaliculi occur close to the outer margin.

B d 365. A vertical section of the same bone, in which the Haversian canals run for a short distance in parallel lines; they are of large size, and the laminæ well marked. Lacunæ of irregular figure, like those occurring in the Haversian interspaces, are very common between the several sets of laminæ.

f. *Persistent appendages to the frontal bones of Ruminants, composed of a bony core coated with dense horny material.*

B d 366. A transverse section of the bony core of the horn of a Sheep, *Ovis aries*, which is composed of a regular network of cancelli; when viewed with a power of 100 diameters, the cancelli are found to be surrounded with a series of very strongly-marked laminæ; lacunæ exist, but very few of them exhibit canaliculi; the bone between them is in the form of granules, which are so numerous as to render nearly every part opaque.

B d 367. A longitudinal section of the same bone, in which the cancelli are divided vertically; the lacunæ and their canaliculi are more abundant and better seen than in the preceding specimen; but the bony matter between them is in a very granular condition. The broad opaque laminæ alluded to in the transverse section, are in this one seen to the greatest advantage.

B d 368. A transverse section of the bony core of the horn of a Goat, *Capra hircus*; it is made up of the same kind of cancellated tissue as that of

the Sheep, but the specimen is in the form of a triangle. Most of the cancelli are of circular figure and each surrounded with several broad laminæ, having lacunæ between them. The bone is much more transparent than that of the Sheep, and both lacunæ and canaliculi more nearly resemble those of a long bone of the same animal.

B d 369. A longitudinal section of the same bone, in which the cancelli are divided vertically; the lacunæ are mostly disposed in parallel rows, but the bone between them is opaque and granular.

B d 370. A transverse section of the cuticular layer covering the bony core of the horn of a *Cow*, taken from near the tip where the horn is solid. It is made up of a series of minute wavy laminæ, which are crossed at equal distances by opaque radii composed of granules of earthy material; near the centre of the section the earthy matter is more abundant, and it is there arranged in the form of a coarse hexagonal network, visible to the naked eye; the radii in some situations appear as if they were disposed in the form of a network having long meshes. This preparation is seen to the greatest advantage under polarized light.

B d 371. A longitudinal section of the same horn, which is made up of a series of parallel laminæ of nearly structureless material; in some situations there are granules of earthy matter like those described in the transverse section.

# Division II.

## HISTOLOGY OF ANIMALS.

### Subseries XVIII. *Exo-skeleton of Mammalia.*

The exo-skeleton of Mammalia is most largely developed in the order Bruta; in some species of Armadillo it consists of a dense bony covering termed a *carapace*, which not unfrequently is upwards of one-fourth of an inch in thickness. But the most remarkable example of it is to be found in the extinct *Glyptodon*, the carapace of which animal is composed of a series of pentagonal ossicles upwards of an inch thick, and these are united together by sutures at their margins. The Pangolins, which belong to the same order as the Armadillos, have their exo-skeleton in the form of imbricated plates or scales composed of a brown horny material nearly as dense as tortoiseshell; these cover their body, limbs, and tail.

a. *Exo-skeleton in the form of a bony Carapace.*

B d 372. A vertical section of the carapace of an Armadillo, *Dasypus Peba*; it is $\frac{1}{6}$th of an inch in thickness, and the circumferential portion is made up of dense bone, in which very few traces of laminæ exist, but the central exhibits Haversian canals with a concentric arrangement of laminæ and lacunæ around them. The lacunæ in the circumferential portion are of small size, with very long and fine branching canaliculi, some of which form amongst themselves a network enclosing the oval cell-like bodies before described in the Pig and Pig-tailed Baboon; the lacunæ of the central portion are of the usual form.

B d 373. A horizontal section of the same carapace, in which the Haversian canals are very numerous, but are arranged without much order. The lacunæ are of every variety of shape, and, as a general rule, follow the

course of the canals; some of them have few if any canaliculi, others are abundantly supplied with them. Many parts of the section exhibit the peculiar markings so often alluded to in former specimens as modified canaliculi.

B d 374. A vertical section of one of the ossicles of the carapace of the extinct Glyptodon, *Glyptodon clavipes*, like the specimens of human bone, Preparations B d 348 to 350. It is so much impregnated with earthy matter, that very little of the structure is preserved, but still there is sufficient to show that it is made up of a series of large Haversian systems surrounded with laminæ and lacunæ.

B d 375. A horizontal section of the same bone, in which the canals run in the same manner as in a longitudinal one of bone. The lacunæ can be seen in several situations; they measure $\frac{1}{900}$th of an inch in their long diameter, but they are rendered very transparent by the Canada balsam, in which the specimen is mounted.

b. *Exo-skeleton in the form of a horny Carapace.*

B d 376. A vertical section of one of the imbricated scales of a large *Pangolin*; it is composed of a series of parallel laminæ of horny material, between many of which there is a deposition of osseous matter in the form of minute granules. When viewed by polarized light, there is an appearance as if some of the laminæ were made up of cells.

B d 377. A horizontal section of the same scale, in which the disposition of the earthy material is represented by so many curved opaque lines, visible to the naked eye. The other portion being transparent, the cellular structure described in the preceding specimen is not so perceptible in this one.

# Division II.

## HISTOLOGY OF ANIMALS.

### Subseries XIX. *Splanchno-skeleton of Mammalia.*

The splanchno or visceral skeleton of Mammalia is represented by the bones found in the heart of most old Ruminants, and in the Hog, by the os hyoides, and by a bone in the penis which occurs in most of the Apes, in a few Rodents, and in nearly all the Carnivora. But whatever be the shape of the bone, it always exhibits Haversian canals, lacunæ and canaliculi, like the bones entering into the formation of the endo-skeleton; but the earthy material is in a granular condition, as is well shown by the following preparations.

B d 378. A transverse section of one of the pieces of bone found in the heart of an Ox, *Bos Taurus*; it consists of a thin shell enclosing a central cavity. When examined with a power of 250 diameters, the Haversian canals will be seen to be surrounded with laminæ and lacunæ, like those of a long bone of the same animal, the principal difference being the abundance of earthy particles in some situations.

B d 379. A longitudinal section of the same bone, in which the lacunæ are mostly of rounded figure, some few being disposed in parallel rows. Like the preceding specimen, the bony matter in certain situations is opaque and granular.

B d 380. A transverse section of the os penis of a Walrus, *Trichecus Rosmarus*, which is entirely made up of a series of Haversian systems of various sizes, each surrounded with a concentric arrangement of laminæ and lacunæ. The principal difference between this and a corresponding section of a long bone of the same animal is the granular condition of bone in certain situations.

B d 381. A longitudinal section of the same bone, in which both canals and lacunæ are disposed in parallel rows; the canaliculi are very well seen in some situations, but, as a general rule, they are obscured by the granular condition of the earthy matter.

END OF VOL. II.

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# EXPLANATION OF THE PLATES.

## PLATE I.

Fig. 1. *a*. One of the discs removed from the sheath of the vertebral column of a Lancelet, *Amphioxus lanceolatus*, represented of its natural size. *b*. A segment of the same disc, more highly magnified.

Fig. 2. Fibres taken from the articular ring of a vertebra of a Shark.

Fig. 3. Two fibres from the same preparation, magnified 440 diameters.

Fig. 4. A transverse section of one of the vertebræ of a Vaagmaer, *Vogmarus Islandicus*, showing the cartilaginous radii.

Fig. 5. One of the radii, showing a tube passing through a row of tubular cells.

Fig. 6. A transverse section of one of the vertebræ of a young Shark, showing the parts becoming ossified. *a*. A group of cartilage-cells from the same vertebra.

Fig. 7. A transverse section of one of the vertebræ of a young Dog-fish, *Spinax acanthias*; all the dark parts show ossification commencing.

Fig. 8. A horizontal section from the jaw of a Common Pike, *Esox lucius*, showing vascular canals divided transversely.

Fig. 9. A series of splanchno-ribs of the Lancelet.

Fig. 10. Portions of three of the same, magnified 250 diameters, showing their mode of connexion.

Fig. 11. *a*. A transverse section of the chorda dorsalis of a Lamprey, *Petromyzon marinus*, represented of its natural size. *b*. A portion of the same more highly magnified.

Fig. 12. Cells from the centre of the chorda dorsalis of the Lamprey, some of which exhibit nuclei.

Fig. 13. A group of cartilage-cells from the cranium of a Skate, *Raia Batis*, imbedded in a structureless matrix.

Fig. 14. A group of cartilage-cells from the cranium of the same fish, showing the ossification of the matrix, by deposition of bony granules in its substance.

Fig. 15. A transverse section of a portion of the body of a vertebra of a Basking Shark, *Selache maxima*, showing that the bone is produced by the ossification of the matrix surrounding the cartilage-cells.

Fig. 16. A vertical section of a portion of one of the bony rays of the same Shark, showing the rings of osseous matter surrounding the cartilage-cells.

Fig. 17. Fibres coated with granular matter occurring in a horizontal section of the ring of a vertebra of the same fish.

Fig. 18. A vertical section of a portion of the ring of the body of a vertebra of the same fish.

Fig. 19. A horizontal section of a portion of the ring of the body of a vertebra of the same fish.

Fig. 20. A portion of the osseous crust investing the cranial cartilage of a Dog-fish, *Spinax acanthias*, composed of a series of hexagonal plates enclosing cartilage-cells.

Fig. 21. One of the hexagons, from the same crust, showing the arrangement of the cartilage-cells within the hexagon.

Fig. 22. One of the vertebræ of a fœtal Shark, showing the manner in which ossification commences.

Fig. 23. A vertical section of the vertebral column of a *Chimæra callorhynchus*. *a*. The sheath. *b*. The chorda dorsalis. *c*. The cartilage composing the remainder of the vertebra.

Fig. 24. A portion of the sheath of the chorda dorsalis of the same fish, showing cartilage-cells amongst the fibres.

Fig. 25. Cartilage-cells from the vertebra of the same fish, taken from the part marked *c*, fig. 23.

Fig. 26. A portion of the cranial cartilage of a fœtal Torpedo, *Torpedo vulgaris*, showing the commencing formation of the osseous crust.

Fig. 27. A vertical section of the vertebral column of a Lamprey, *Petromyzon marinus*. *a*. Chorda dorsalis, with its sheath. *b*. The neural, and *c*. the hæmal canals. *d*. Tissue composing remainder of vertebra.

Fig. 28. A vertical section of the vertebral column of a Sturgeon, *Acipenser*. *a*. Hæmal canal. *b*. Neural canal.

Fig. 29. Transverse section of the body of the vertebra of a Shark ; represented the natural size.

Fig. 30. Articular surface of the same vertebra.

Fig. 31. A portion of the tissue composing the vertebra of a Lamprey, removed from the part marked *d*, fig. 27 ; it is made up of adipose cells and fibres.

Fig. 32. A similar preparation from which the fatty matter has been removed by ether.

Fig. 33. A portion of the vertebral column of a Trout five days old. At *a*. are seen cells like those composing the chorda dorsalis of the Lamprey. *b*. Spinous processes made up of ossifying cartilage.

Fig. 34. Cartilage-cells from the vertebra of the Sturgeon represented in fig. 28.

Fig. 35. A vertical section of the cranial cartilage of a Skate, *Raia Batis*, showing the thickness of the osseous crust.

Fig. 36. A transverse section of firm cartilage connected with the tongue of the *Lamprey* ; it is of an oval form, and consists of cellular cartilage.

Fig. 37. A portion of the margin of the same specimen, showing the diminution in size of the cells from the centre to the circumference.

# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF FISHES.

Plate I.

S.W. Leonard, del. et lith.

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## PLATE II.

Fig. 1. One of the vertebræ of a Blue Shark, *Carcharias glaucus*, with its articulating surface uppermost. *a*, *b*. A line indicating the direction in which the section represented by fig. 3 is taken.

Fig. 2. A horizontal section of a vertebra of the same fish, showing the bony radii. *a*, *b*. A line indicating the direction in which the section represented by fig. 4 is taken.

Fig. 3. A vertical section of a vertebra of the Blue Shark. *a a*. Portions of the articular ring. *b*. Cartilage making up the remainder of the vertebra.

Fig. 4. Tangental section of the same vertebra. *a a*. Osseous bands forming the articular ring.

Fig. 5. A horizontal section of the cartilage of a body of a vertebra of the same fish.

Fig. 6. A portion of the articular ring of the same vertebra.

Fig. 7. A vertical section of the cartilage of the same vertebra.

Fig. 8. A vertical section of the articular ring of the same vertebra.

Fig. 9. A tangental section of the cartilage of the same vertebra.

Fig. 10. A tangental section of the articular ring of the same vertebra.

Fig. 11. A horizontal section of the vertebra of a Tope, *Squalus galeus*.

Fig. 12. A horizontal section of a portion of the same vertebra.

Fig. 13. A vertical section of the vertebra of the same Tope. *a a*. Articular surfaces. *b b*. Bony matter making up the body of the vertebra.

Fig. 14. A vertical section of a portion of the body of the same vertebra.

Fig. 15. A transverse section of a vertebra of a young Fishing-frog, *Lophius piscatorius*.

Fig. 16. A portion of the same section, showing two of the bony radii and the fibrous tissue between them.

Fig. 17. A horizontal section of a vertebra of the same fish.

Fig. 18. A portion of the same section, showing one of the bony radii and the fibrous tissue in connexion with it.

Fig. 19. A portion of a horizontal section of a vertebra from a Basking Shark, *Selache maxima*, represented of one-third its natural size.

Fig. 20. A vertical section of the same vertebra, also represented of one-third its natural size.

Fig. 21. A vertical section of a portion of the ring of a vertebra of the same fish.

Fig. 22. A horizontal section of a portion of the ring of a vertebra of the same fish.

Fig. 23. A transverse section of the body of the same vertebra, one-half of which is composed of cartilage, and the other of bone.

Fig. 24. A portion of a horizontal section of a vertebra of a fossil Shark, from the Isle of Sheppey. *a*. The section represented of its natural size.

Fig. 25. A portion of the articular ring of a Skate, belonging to the genus *Rhina*, showing fusiform cells between the fibres.

Fig. 26. A transverse section of the vertebral column of a Skate, belonging to the genus *Rhina*. *a*. Concave articular surface of the centrum of the vertebra. *b*. Neural canal. *c*. Hæmal canal. *d*. Cartilage above the neural canal.

Fig. 27. A longitudinal section of one of the vertebræ of the same fish.

Fig. 28. Fibres from the articular ring of a vertebra of a Shark, *Selache maxima*.

Fig. 29. A transverse section of one of the vertebræ from the tail of a Thornback, *Raia clavata*. *a*. A layer of osseous matter lining the neural canal.

Fig. 30. A portion of ossifying cartilage, from a vertebra of the same fish.

Fig. 31. A group of cartilage-cells from a vertebra of the same fish.

# HISTOLOGY OF ANIMALS.
# ENDO-SKELETON OF FISHES.

PLATE II.

Fig.1.

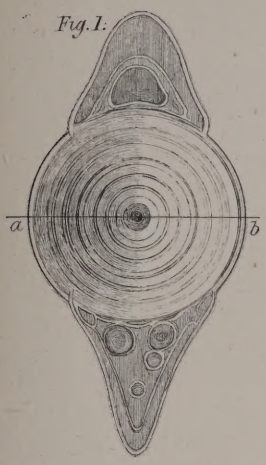
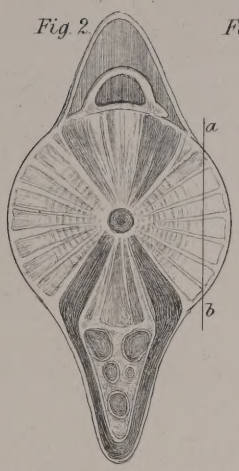



Fig.2.

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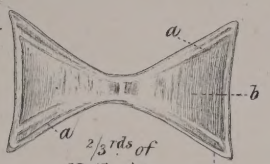
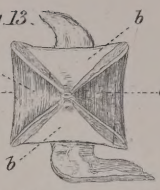



Fig.11.

Nat.l size

Fig.13.

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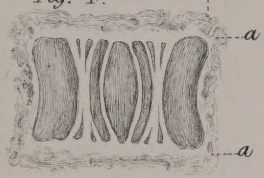
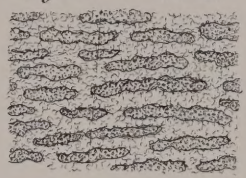



Fig.12. 200 dias



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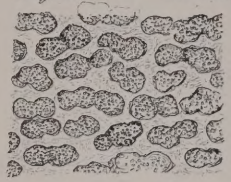


Fig.5. 200 dias

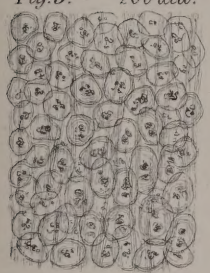


Fig.6 200 dias

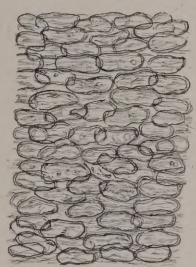


Fig.15. 7 dias

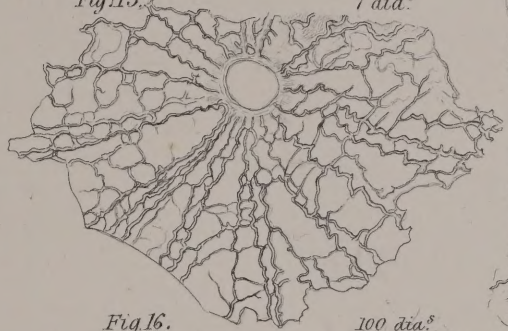


Fig.17. 7 dias

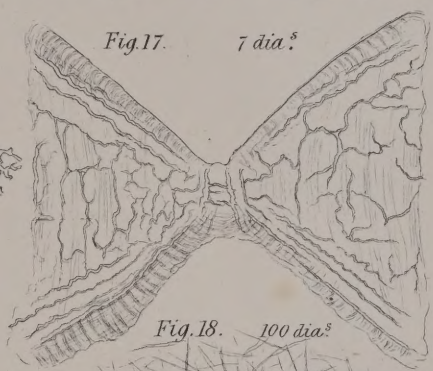


Fig.18. 100 dias

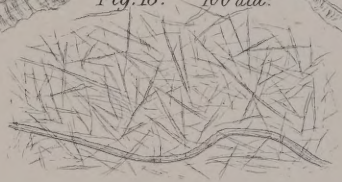


Fig.7 200 dias

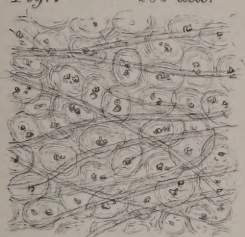


Fig.8. 200 dias

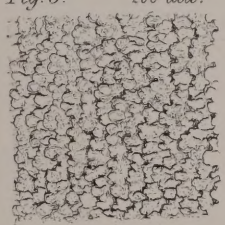


Fig.16. 100 dias

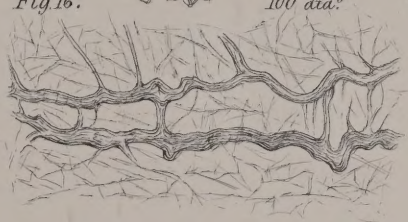
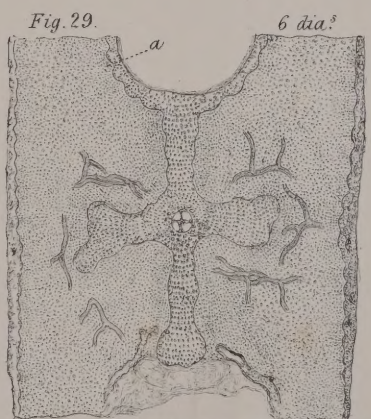


Fig.19

a Natl size.

Fig.29.




6 dias

Fig.9. 200 dias

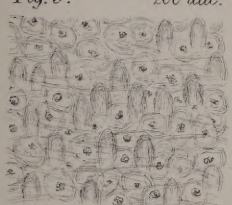


Fig.10. 200 dias

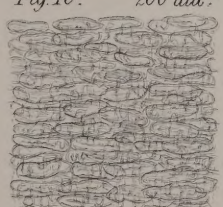


Fig.20. 1/3 Natl size.

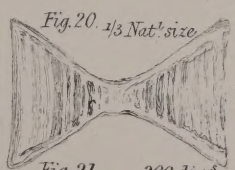


Fig.24. 200 dia.

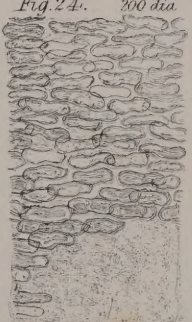


Fig.26

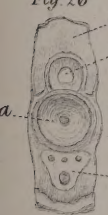



Fig.27.

Fig.22. 200 dias

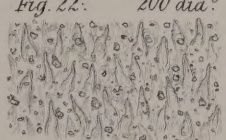


Fig.21 200 dias

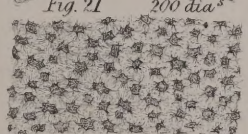


Fig.31. 200 dias

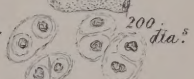


Fig.30. 100 dias

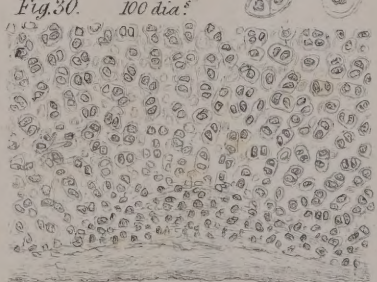


Fig.25. 200 dias

Fig.23. 200 dias

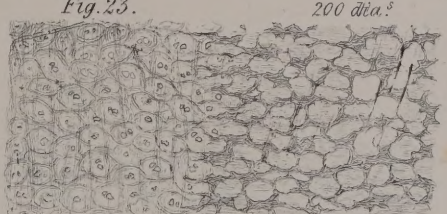
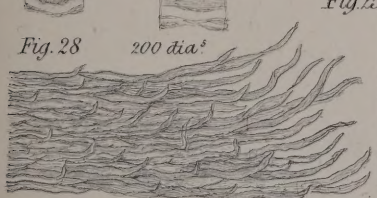


Fig.28 200 dias



J.W. Leonard, del. et lith.

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## PLATE III.

Fig. 1. Horizontal section of the osseous crust investing the rostrum of a Saw-fish, *Pristis cuspidatus.*

Fig. 2. A portion of one of the hexagons of the same osseous crust, more highly magnified.

Fig. 3. Transverse section of a portion of the rostrum of a Saw-fish. *a.* Inner layer composed of dense prisms.

Fig. 4. A portion of fig. 3, more highly magnified.

Fig. 5. Prism from the outer row, magnified 25 diameters.

Fig. 6. Portion of the same, magnified 130 diameters.

Fig. 7. Portion of an inner prism, magnified 25 diameters.

Fig. 8. Portion of the same, magnified 130 diameters.

Fig. 9. Horizontal section of the rostrum of *Pristis cuspidatus,* showing an aggregation of cells in the centre of each hexagon.

Fig. 10. Vertical section of the rostrum of *Pristis cuspidatus,* from which the earthy matter has been removed.

Fig. 11. A portion of the same preparation, magnified 250 diameters.

Fig. 12. A portion of the skin of the rostrum of *Pristis antiquorum.*

Fig. 13. Vertical section of soft bone found at the root of a tooth of a Saw-fish, *Pristis antiquorum.*

Fig. 14. A portion of the same, more highly magnified.

Fig. 15. Vertical section of the septum of the rostrum of *Pristis cuspidatus,* deprived of its earthy matter.

Fig. 16. A horizontal section of a portion of the osseous crust of the rostrum of *Pristis cuspidatus,* deprived of its earthy matter.

Fig. 17. Vertical section of jaw of Shark, *Carcharias glaucus,* showing the osseous crust investing its outer and inner surface.

Fig. 18. A prism, from the same crust, more highly magnified.

Fig. 19. Cartilage-cells from the same prism, magnified 250 diameters.

Fig. 20. Horizontal section of osseous crust of the lower jaw of a Shark, *Galeus ferox. a a.* Canals occurring between the hexagons.

Fig. 21. Portion of the osseous crust of an adult Thornback.

Fig. 22. Cartilage-cells from the osseous crust of the same fish, more highly magnified.

# HISTOLOGY OF ANIMALS.
## ENDO AND EXO-SKELETON OF FISHES.

Plate, III.

Fig. 1 20. dia.s

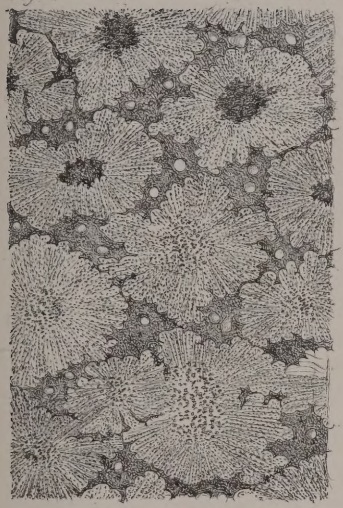


Fig. 2. 100. dia.s

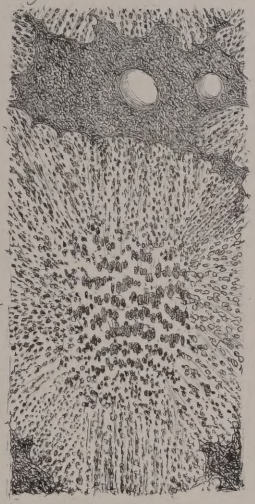


Fig. 3. Nat.l Size

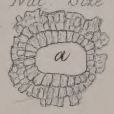



Fig. 4 8 dia.s

Fig. 5. 25. dia.s

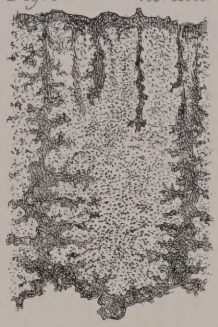


Fig. 6. 130. dia.s

Fig. 7. 25. dia.s

Fig. 8. 130. dia.s

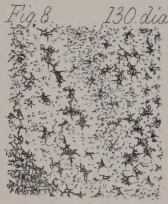


Fig. 9 25. dia.s

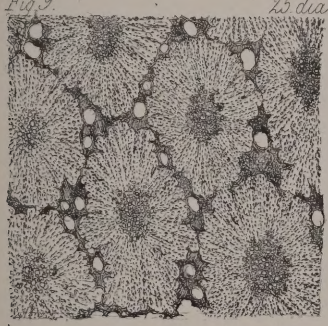


Fig. 10. 25. dia.s

Fig. 12. 100. dia.s

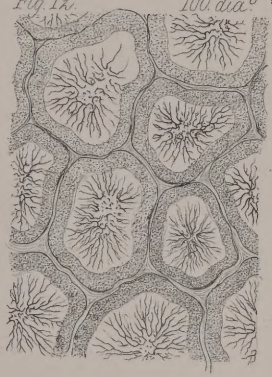


Fig. 13. 50. dia.s

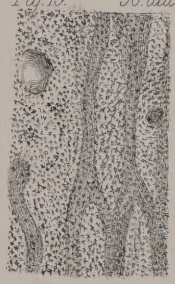


Fig. 14. 200. dia.s

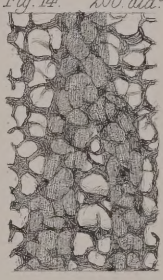


Fig. 15. 25. dia.s

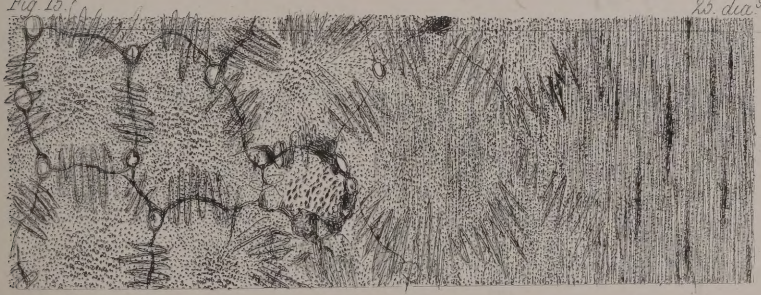


Fig. 11. 250. dia.s

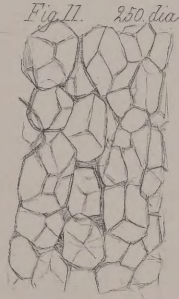


Fig. 16. 25. dia.s

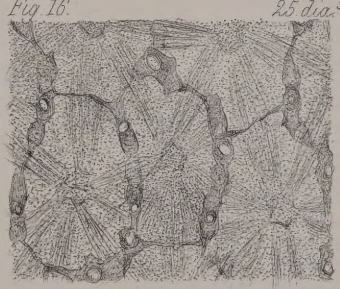


Fig. 17. 17. dia.s

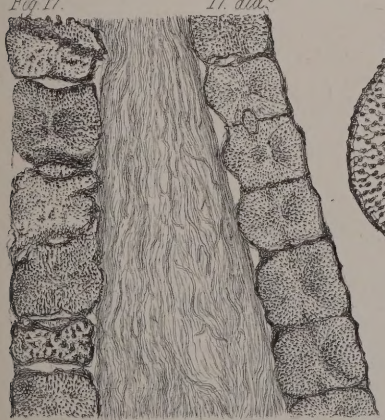


Fig. 18. 100. dia.s

Fig. 19. 250. dia.s

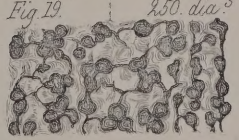


Fig. 20. a 25. dia.s

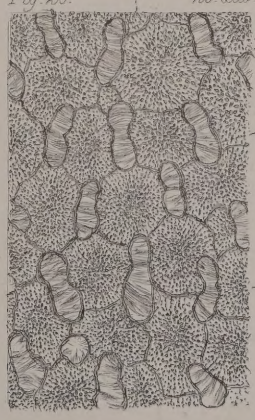



Fig. 21. 25. dia.s

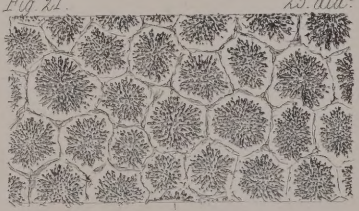
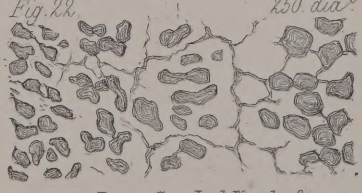


Fig. 22. 250. dia.s



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## PLATE IV.

Fig. 1. Portion of the bony exo-skeleton of a Trunk-fish, *Ostracion triqueter*.

Fig. 2. Portion of the margin of the same, showing canaliculi given off from parallel canals.

Fig. 3. Portion of the bony exo-skeleton of a Trunk-fish, *Ostracion cornutus*.

Fig. 4. Portion of one of the scales, showing the laminated arrangement of the margin, and the lacunæ in the centre.

Fig. 5. Lacunæ from the central portion of the same scale, more highly magnified.

Fig. 6. One of the scales of a small species of *Ostracion*, composed of horny material. *a*. Spine projecting from the centre.

Fig. 7. Portion of bone of *Lepidosteus osseus*.

Fig. 8. Portion of a thin bony plate from vertebra of Tobacco-pipe fish, *Fistularia tabaccaria*, exhibiting lacunæ and elongated canaliculi.

Fig. 9. Transverse section of lower jaw of *Fistularia tabaccaria*, showing elongated canaliculi.

Fig. 10. Thin lamina of a vertebra of *Fistularia*, showing the peculiar lacunæ.

Fig. 11. Portion of lower jaw of *Fistularia*, showing elongated canaliculi given off from Haversian canals.

Fig. 12. Portion of the same preparation, more highly magnified.

Fig. 13. Longitudinal section of lower jaw of *Fistularia tabaccaria*, showing elongated canaliculi proceeding from Haversian canals.

Fig. 14. Portion of the same specimen, more highly magnified.

Fig. 15. Transverse section of one of the vertebræ of *Fistularia tabaccaria*, of the natural size. *a*, *b*, *c*, indicate the precise situation from which figs. 16, 17 and 18 have been taken.

Fig. 16. The part marked *a*, in fig. 15, more highly magnified.

Fig. 17. The part marked *b*, in fig. 15, more highly magnified.

Fig. 18. The part marked *c*, in fig. 15, more highly magnified.

Fig. 19. Longitudinal section of the body of a vertebra of *Fistularia tabaccaria*, showing long Haversian canals from which branching canaliculi are given off.

Fig. 20. Portion of the same, more highly magnified.

# HISTOLOGY OF ANIMALS.
## EXO AND ENDO-SKELETON OF FISHES.

Plate IV.

Fig.1. 8 diam.s

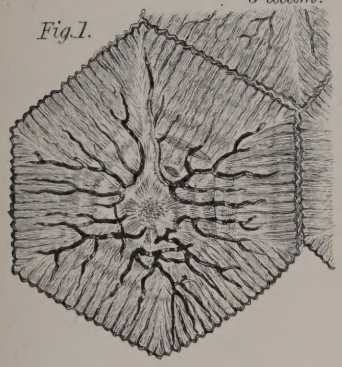

Fig.2. 130 diam.s

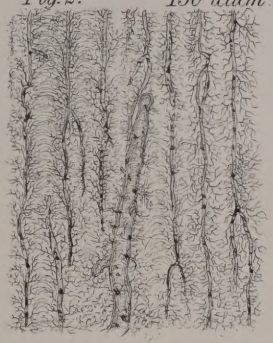

Fig.5. 250 diam.s

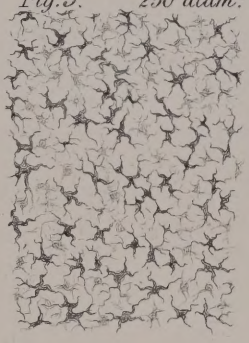

Fig.3. 7 diam.s

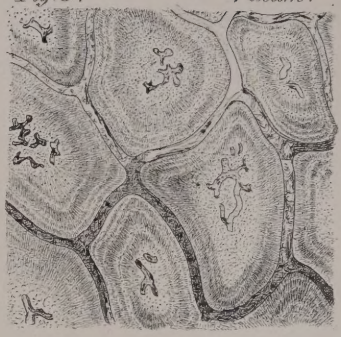

Fig.7. 8 diam.s

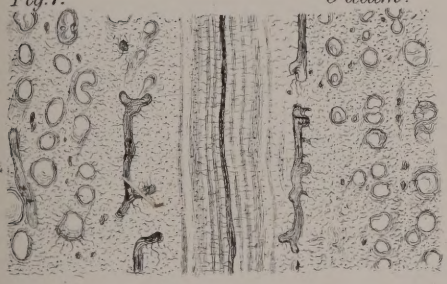

Fig.6. a 40 diam.s

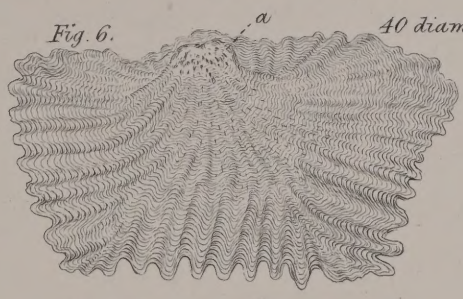

Fig.4. 130 diam.s

Fig.8. 130 diam.s

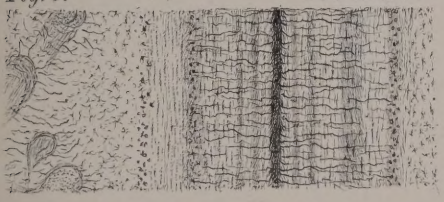

Fig.11. 50 diam.s

Fig.12. 200 diam.s

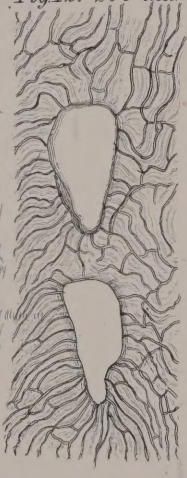

Fig.13. 50 diam.s

Fig.14. 200 diam.s

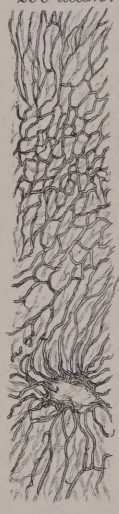

Fig.9. 130 diam.s

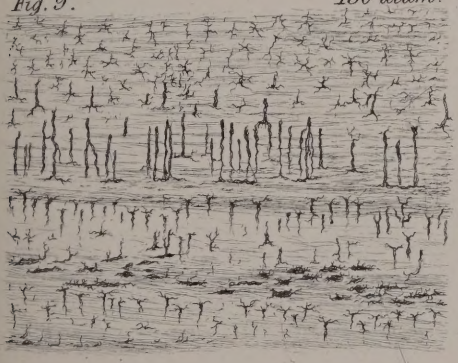

Fig.10. 130 diam.s

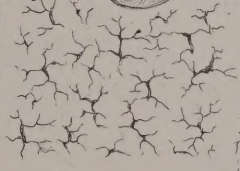

Fig.15.

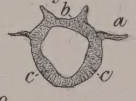


Fig.18. c 50 diam.s

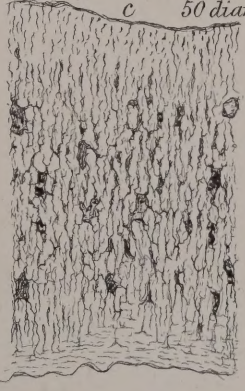

Fig.19. 50 diam.s

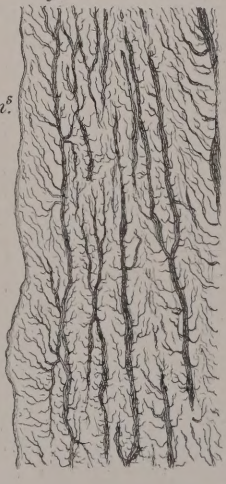

Fig.20. 200 diam.s

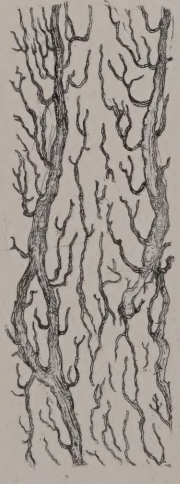

Fig.16. a 50 diam.s

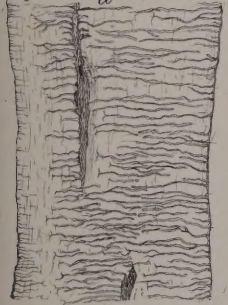

Fig.17. b 50 diam.s

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## PLATE V.

Fig. 1. Transverse section of cranial bone of *Megalichthys Hibberti.*

Fig. 2. Portion of the same bone, more highly magnified.

Fig. 3. Group of lacunæ from the same bone, magnified 440 diameters.

Fig. 4. Longitudinal section of the same bone, showing the parallel arrangement of the lacunæ.

Fig. 5. A few of the lacunæ, more highly magnified.

Fig. 6. Transverse section of a bone of a large fossil *Fish,* from the limestone of Burdie House, near Edinburgh.

Fig. 7. Portion of the same, more highly magnified.

Fig. 8. A transverse section of a bone of the same fossil fish.

Fig. 9. Portion of the same section, more highly magnified.

Fig. 10. Longitudinal section of the same bone, in which the lacunæ are of great length, and cross each other, as in some of the Reptilia.

Fig. 11. Portion of the same section, more highly magnified.

Fig. 12. A lacuna seen in its entire length ; its long diameter is $\frac{1}{160}$th of an inch.

Fig. 13. Portion of the surface of a large Fish-scale, from a fish probably of the genus *Holoptychius.*

Fig. 14. Portion of the same scale, more highly magnified.

Fig. 15. Two of the oval lacunæ, magnified 440 diameters.

Fig. 16. Transverse section of one of the bones of the cranium of a fossil Fish, probably *Rhizodus.*

Fig. 17. A few of the lacunæ from the same specimen, more highly magnified.

Fig. 18. Lacunæ seen in a vertical section of the jaw of the same *Fish.*

Fig. 19. Five of the lacunæ from the same, more highly magnified.

Fig. 20. Longitudinal section of a cranial bone of *Lepidosiren annectens.*

Fig. 21. Two of the lacunæ, more highly magnified.

Fig. 22. Longitudinal section of a cranial bone of the same *Lepidosiren,* in which the lacunæ are disposed in parallel rows.

Fig. 23. Two of the lacunæ from the same specimen, magnified 440 diameters.

# HISTOLOGY OF ANIMALS
## ENDO-SKELETON OF FISHES.



Fig. 1. 15 diam.s

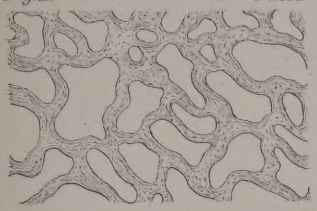


Fig. 3. 440.

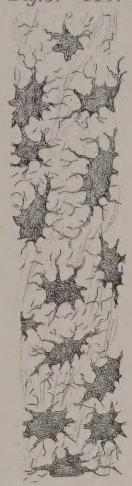


Fig. 4. 95 diam.s

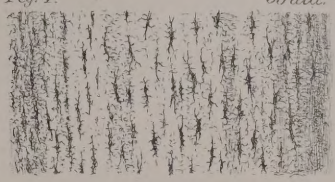


Fig. 15. 440.

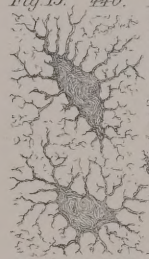


Fig. 13. a 95 diam.s

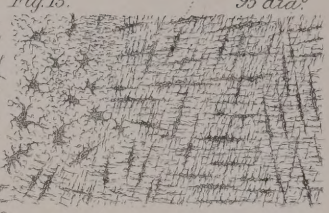


Fig. 2. 95 diam.s

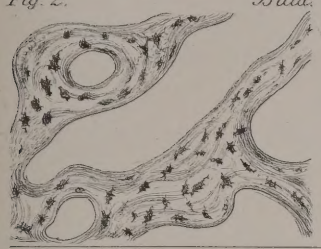


Fig. 5. 440 diam.s

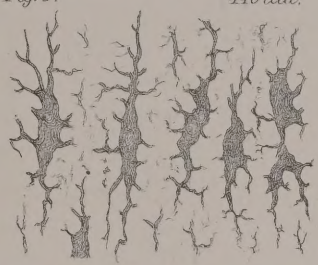


Fig. 14. 440 diam.s

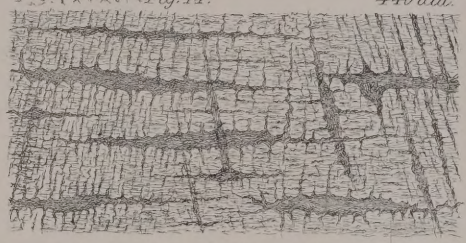


Fig. 10. 95 diam.s

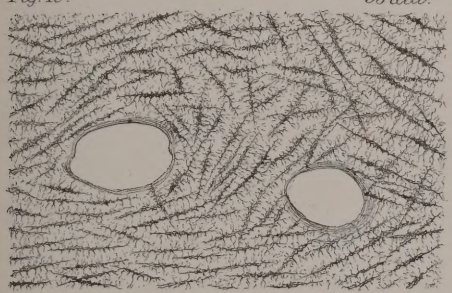


Fig. 12.

Fig. 6. 95 diam.s

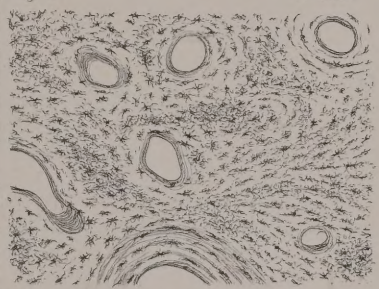


Fig. 8. 95 diam.s

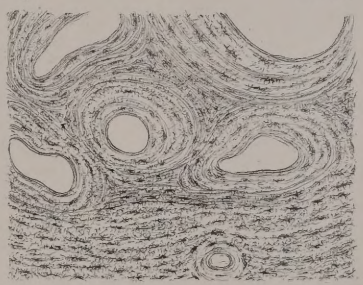


Fig. 11. 440 diam.s

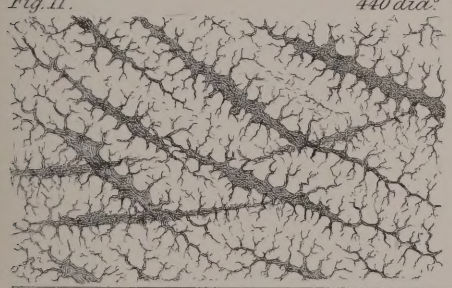


Fig. 7. 440 diam.s

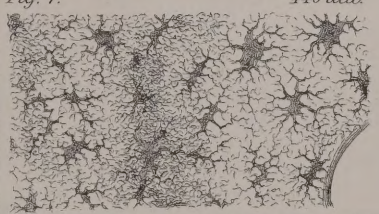


Fig. 9. 440 diam.s

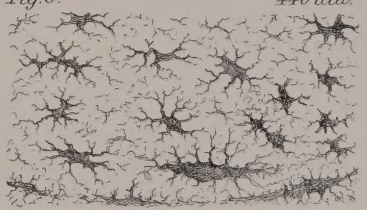


Fig. 16. 95 diam.s

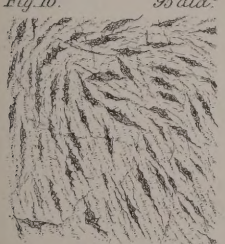


Fig. 18. 95 diam.s

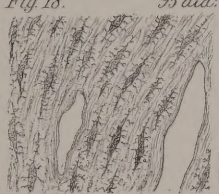


Fig. 20. 95 diam.s

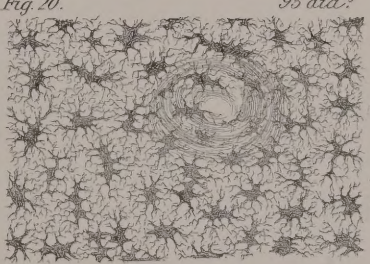


Fig. 22. 95 diam.s

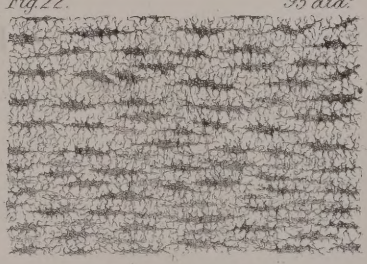


Fig. 19. 440 diam.s

Fig. 17. 440 diam.s

Fig. 21. 440 diam.s

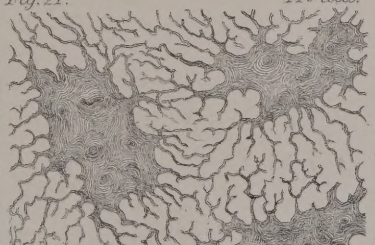
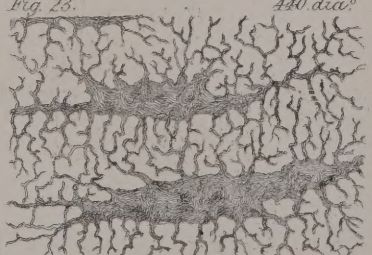


Fig. 23. 440 diam.s



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## PLATE VI.

Fig. 1. Scale of the *Eel.*

*a.* Scale of the natural size.
*b.* The same scale, magnified 12 diameters.

Fig. 2. Upper half of the same scale, more highly magnified.

Fig. 3. Portion of the same scale, magnified 200 diameters.

Fig. 4. Scale of the Sand-eel, magnified 40 diameters. *a.* Posterior or free margin of the scale. *b.* Anterior portion, imbedded in the skin.

Fig. 5. Horizontal section of one of the scales of a large Tunny, *Thynnus communis.*

Fig. 6. Vertical section of the scale of a Tunny. *a.* natural size. *b.* Portion of the same section, more highly magnified.

Fig. 7. Horizontal section of the cancellated portion of the same scale.

Fig. 8. Portion of the same specimen, more highly magnified; in all these preparations the lacunæ will be seen to have no canaliculi.

Fig. 9. Portion of the outer surface of a scale of *Megalichthys Hibberti.*

Fig. 10. A similar specimen, more highly magnified.

Fig. 11. Vertical section of a scale of *Megalichthys Hibberti.* *a.* Hexagonal structure forming the surface of the scale.

Fig. 12. Lower portion of the same scale.

Fig. 13. Vertical section of the scale of a Hassar-fish, *Callichthys.*

Fig. 14. Horizontal section of a similar scale, showing a network of large canals.

Fig. 15. Vertical section of another scale of the same fish, in which the canals are divided lengthwise.

Fig. 16. Segment of a small scale of *Lepidosteus osseus.*

Fig. 17. Portion of the same, more highly magnified.

Fig. 18. Granular structure of outer layer of the same scale.

Fig. 19. Vertical section of the scale of a *Lepidosteus,* showing a layer of ganoin. *a a.* Tubes passing into the ganoin.

Fig. 20. The entire section, magnified 7 diameters.

Fig. 21. Section through the middle, magnified 40 diameters.

Fig. 22. Segment taken from the lower portion of the same scale: the dark bands in this section are produced by minute straight canaliculi.

# HISTOLOGY OF ANIMALS.
## EXO-SKELETON OF FISHES.

Fig 1.
12 diam.s
b

Fig. 2.
Nat. size
a
25 diam.s

Fig. 4.
40 diam.s

Fig. 5.
130 diam.s
a
b

a Natl size
Fig. 6.
40 diam.s
b

Fig. 3.
200 diam.s

Fig. 9.
40 diam.s

Fig. 7.
25 diam.s

Fig. 8.
130 diam.s

Fig. 11.
25 diam.s
a

Fig. 10.
130 diam.s

Fig. 14.
130 diam.s

Fig. 16.
25 diam.s

Fig. 13.
40 diam.s

Fig. 12.
25 diam.s

Fig. 15.
40 diam.s

Fig. 17.
130 diam.s

Fig. 20.
7 diam.s

Fig. 19.
40 diam.s
a
a

Fig. 22.
40 diam.s

Fig. 21.
40 diam.s

Fig. 18.
130 diam.s

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## PLATE VII.

Fig. 1. A horizontal section of the dorsal spine of a Hassar-fish (*Callichthys*). *a*. Transverse section of the spine, of the natural size.

Fig. 2. Vertical section of the same spine.

Fig. 3. Horizontal section of a portion of the same spine, showing lacunæ.

Fig. 4. *a*. Transverse section of the dermal spine of a Globe-fish, of the natural size. *b*. Segment of the same, magnified 100 diameters.

Fig. 5. Transverse section of the dorsal spine of a Dog-fish. *a*. Section of the natural size. *b*. The same section, magnified 25 diameters. *c c*. Haversian canals.

Fig. 6. A vertical section of the spine of the same Dog-fish. *a*. Canals on outer margin.

Fig. 7. A transverse section of a dorsal spine of *Polypterus niloticus*. *a a*. Ganoid layer.

Fig. 8. Vertical section of dorsal spine of *Polypterus niloticus*.

Fig. 9. A transverse section of the spine of a *Silurus*. *a*. Natural size.

Fig. 10. Vertical section of the same spine.

Fig. 11. A transverse section of the spine of a fossil fish from the Oolite. *a*. Spine of the natural size. *b*. A portion of the same, magnified 15 diameters. *c*. Portion showing laminæ. *d*. Portion showing Haversian canals.

Fig. 12. A vertical section of the same spine, magnified 15 diameters.

Fig. 13. A vertical section of the scale of a Jew-fish. *a*. Superficial layer. *b*. Middle layer, made up of lenticular granules. *c*. Lower layer. *d d*. Lenticular granules which have coalesced. *e e*. Detached granules.

Fig. 14. A vertical section of the posterior portion of a scale of a large Carp. *a*. Free portion covered with laminæ. *b*. Osseous layer. *c*. Horny internal layer.

Fig. 15. Vertical section of the scale of a large Pike, *Esox Lucius*. *a*. External layer, made up of osseous granules. *b*. Internal layer, made up of laminæ of structureless horn.

Fig. 16. Vertical section of the same scale, in which the furrows, *a*, of the outer surface of the scale, are so deep, that they resemble sections of spines. *b*. Internal layer.

# HISTOLOGY OF ANIMALS.
# EXO-SKELETON OF FISHES.

Plate VII.

Fig. 1.

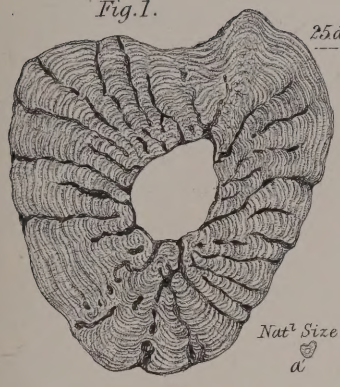



Fig. 2.

Fig. 4. 100 dia.s

Fig. 5. 25 dia.s

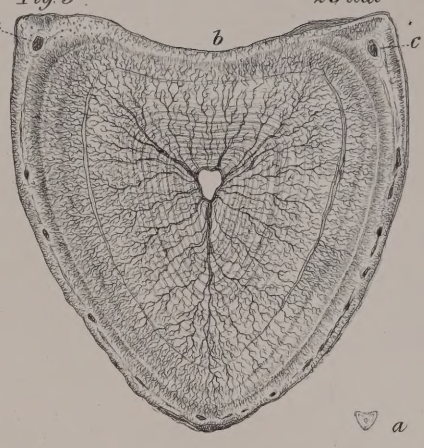



Fig. 3. 100 dia.s

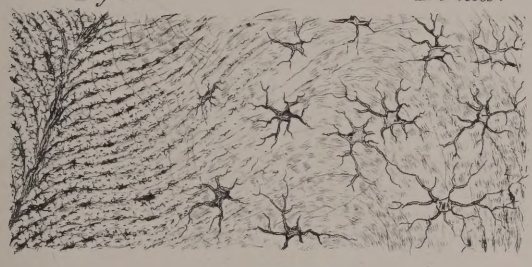


Fig. 6. 25 dia.s

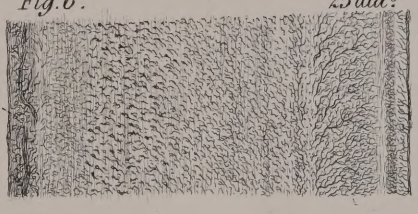



Fig. 7.

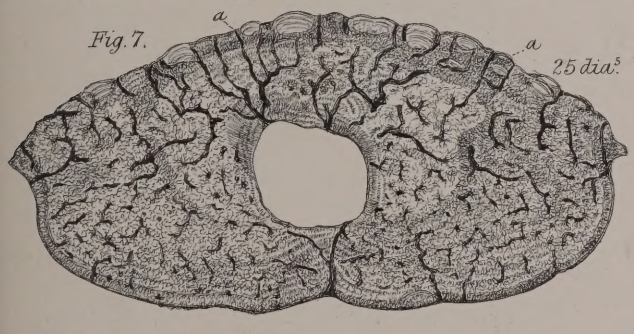



Fig. 9. 15 dia.s

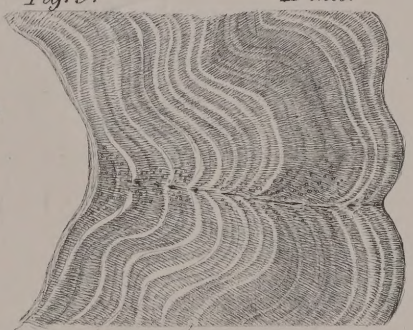


Fig. 10. 15 dia.s

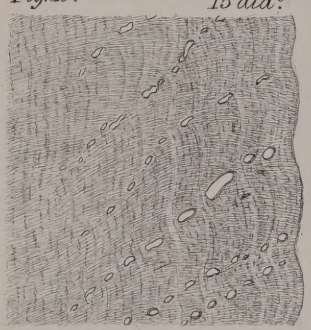
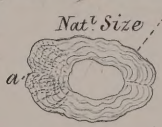


Fig. 8. 25 dia.s

Nat.l Size




Nat.l Size

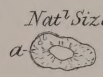



Fig. 11. b 15 dia.s

Fig. 13.

Fig. 15. 150 dia.s

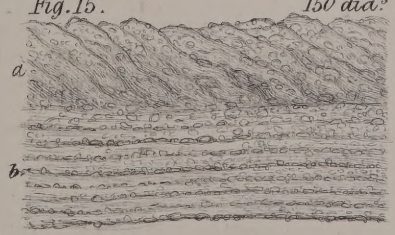



Fig. 14.

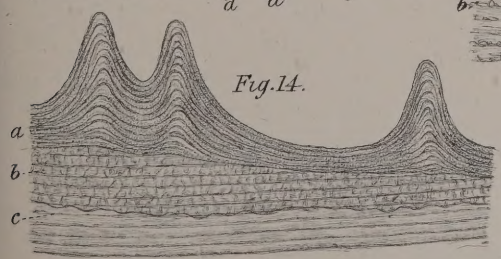



Fig. 16. 150 dia.s

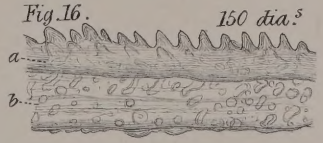
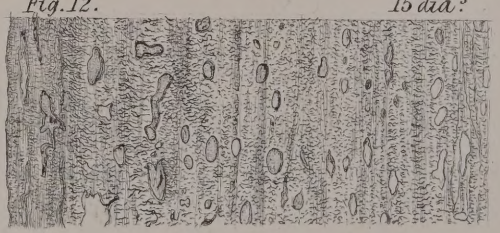



Fig. 12. 15 dia.s



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## PLATE VIII.

Fig. 1. Horizontal section of cranium of *Triton cristatus*.

Fig. 2. Three of the lacunæ, more highly magnified.

Fig. 3. Longitudinal section of femur of *Triton cristatus*.

Fig. 4. Three of the lacunæ, under a higher power.

Fig. 5. Transverse section of humerus of *Siren lacertina*.

Fig. 6. A few of the lacunæ of the same specimen, more highly magnified.

Fig. 7. Vertical section of humerus of *Siren lacertina*.

Fig. 8. Two of the lacunæ from the same specimen, more highly magnified.

Fig. 9. Transverse section of humerus of *Axolotes marmoratus*.

Fig. 10. A few of the lacunæ, more highly magnified.

Fig. 11. Vertical section of the same bone.

Fig. 12. Three of the lacunæ, more highly magnified.

Fig. 13. Transverse section of radius of *Menopoma Alleghaniense*.

Fig. 14. Three of the rounded lacunæ, more highly magnified.

Fig. 15. Vertical section of the same bone.

Fig. 16. Two of the rounded lacunæ, under a power of 440 diameters.

Fig. 17. Transverse section of tibia of *Bufo vulgaris*. *a*. The specimen itself, magnified 8 diameters.

Fig. 18. Lacunæ from transverse section, more highly magnified.

Fig. 19. Two of the lacunæ from the longitudinal section, magnified 440 diameters.

Fig. 20. Transverse section of femur of *Rana temporaria*.

Fig. 21. Portion of the two inner layers, more highly magnified.

Fig. 22. Longitudinal section of the entire breadth of the femur of the same Frog.

Fig. 23. Lacunæ from the centre, crossing each other at various angles, more highly magnified.

Fig. 24. Rounded lacunæ from the margin of the same section, more highly magnified.

Fig. 25. Transverse section of femur of a large Reptile (fossil), probably *Labyrinthodon*.

Fig. 26. Rounded lacunæ from the same specimen, more highly magnified.

Fig. 27. Elongated lacunæ from the same specimen.

Fig. 28. Horizontal section of cranium of *Proteus anguinus*.

Fig. 29. A few of the lacunæ, more highly magnified.

# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF BATRACHIA.

Plate VIII.

Newt

Fig.1. Trans.e 95 diaS

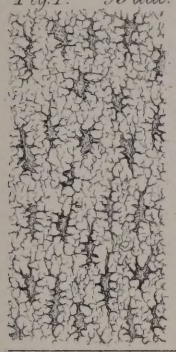


Fig.2 440 diaS

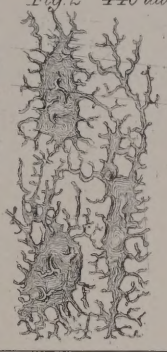
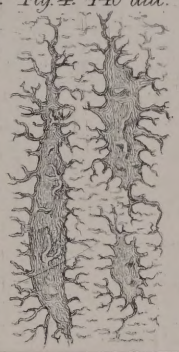


Fig.3. Long.l 95 diaS

Fig.4. 440 diaS



Siren.

Fig.5. Trans.e 95 diaS

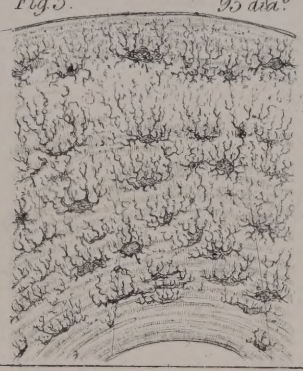
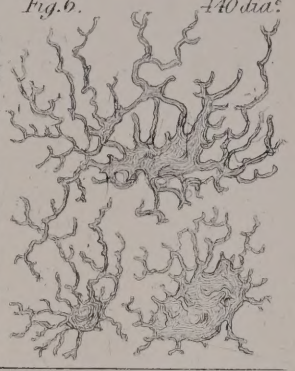


Fig.6. 440 diaS



Siren Longi.l

Fig.7 95 diaS

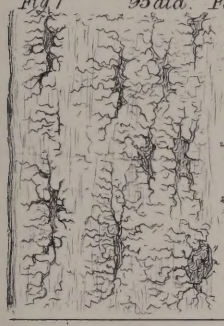
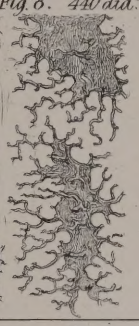


Fig.8. 440 diaS



Axolotl Trans.e

Fig.9 95 diaS

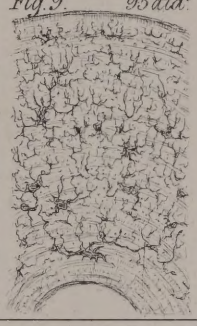
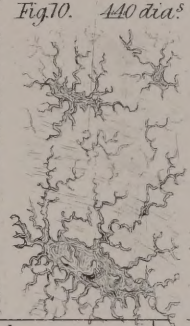


Fig.10. 440 diaS



Axolotl. Longi.l

Fig.11. 95 diaS

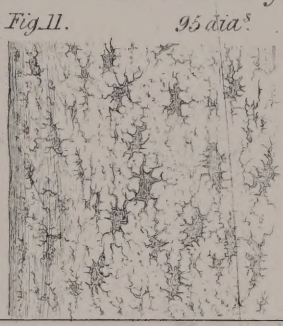


Fig.12. 440 diaS

Trans.e Menopome. Longi.l

Fig.13. 95 diaS

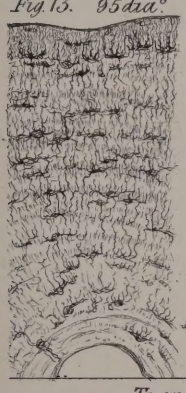


Fig.14. 440 diaS

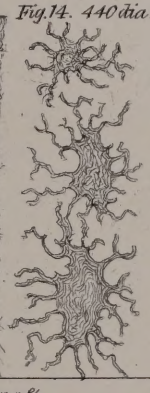


Fig.15. 95 diaS

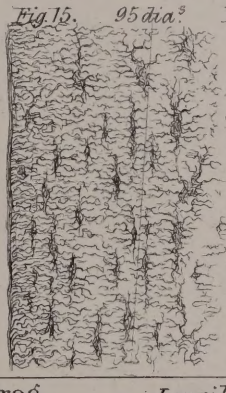


Fig.16. 440 diaS

Trans.e Toad. Longi.l

Fig.17. 95 diaS

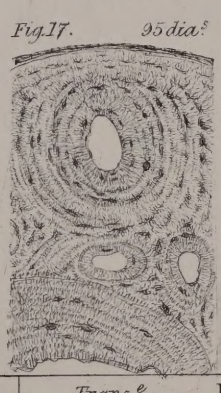


Fig.18. 440 diaS

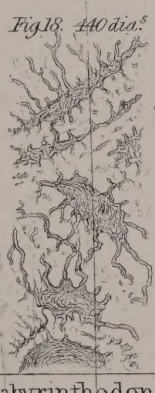


Fig.19. 440 diaS

Tr. Sec.n 8 diaS



a

Trans.e Frog. Longi.l

Fig.20 95 diaS

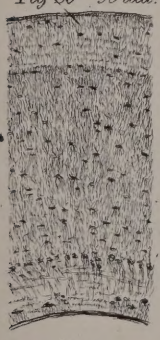


Fig.21. 440 diaS

Fig.23. 440 diaS

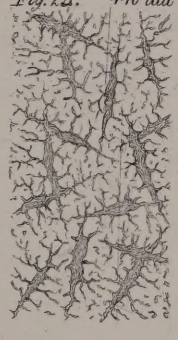
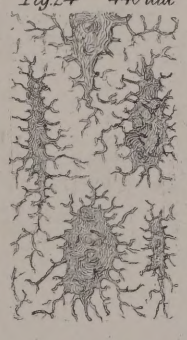


Fig.24 440 diaS



Trans.e Labyrinthodon. Longi.l

Fig.25 95 diaS

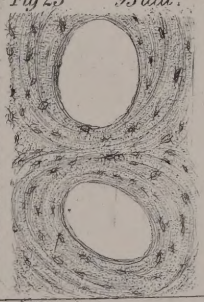


Fig.26 440 diaS

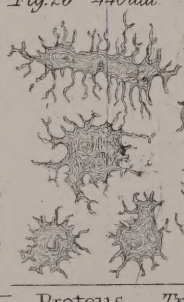
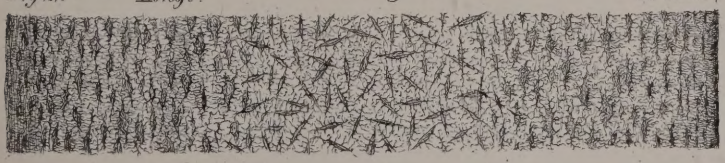


Fig.27 440 diaS

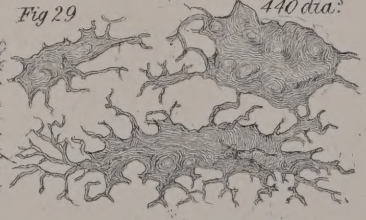
Fig.22 Longi.l Frog. 95 diaS



Proteus. Trans.e

Fig.28. 95 diaS

Fig.29 440 diaS



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## PLATE IX.

Fig. 1. Transverse section of rib of *Python tigris*. *a*. Haversian canal.
Fig. 2. Segment of fig. 1, more highly magnified.
Fig. 3. Lacunæ from same section.
Fig. 4. Vertical section of rib of *Python tigris*.
Fig. 5. Three lacunæ, more highly magnified.
Fig. 6. Transverse section of the femur of *Crocodilus biporcatus*.
Fig. 7. A portion of the same, more highly magnified. *a*. An Haversian canal.
Fig. 8. Vertical section of the femur of the same Crocodile.
Fig. 9. Elongated lacunæ, more highly magnified.
Fig. 10. Transverse section of femur of *Iguana tuberculata*, magnified 3 diameters.
Fig. 11. Segment of the same femur, magnified 95 diameters.
Fig. 12. A few of the lacunæ, more highly magnified.
Fig. 13. Longitudinal section of the same bone.
Fig. 14. Two of the most characteristic of the lacunæ, magnified 440 diameters.
Fig. 15. Transverse section of femur of *Iguanodon Mantelli*.
Fig. 16. A few of the lacunæ, more highly magnified.
Fig. 17. Vertical section of the same bone.
Fig. 18. Portion of the same, more highly magnified.
Fig. 19. Transverse section of femur of *Draco volans*.
Fig. 20. A portion of the same, more highly magnified.
Fig. 21. Vertical section of femur of *Draco volans*. *a*. Elongated lacunæ. *b*. Rounded lacunæ.
Fig. 22. Elongated lacunæ, more highly magnified.
Fig. 23. Rounded lacunæ, more highly magnified.
Fig. 24. Transverse section of wing-bone of *Pterodactyle*, from the chalk of Kent.
Fig. 25. Portion of the same, more highly magnified.
Fig. 26. Lacunæ from the centre of a vertical section of the same *Pterodactyle*.
Fig. 27. Lacunæ from the margin.
Fig. 28. Lacunæ from the centre, more highly magnified.
Fig. 29. Lacunæ from the margin, more highly magnified.
Fig. 30. Transverse section of femur of Monitor Lizard, *Varanus variegatus*.
Fig. 31. Portion of the same, more highly magnified.
Fig. 32. Vertical section of the femur of the same animal.
Fig. 33. A few of the lacunæ, under a higher power.
Fig. 34. Transverse section of the lower jaw of an *Ichthyosaurus*.
Fig. 35. A few of the lacunæ, more highly magnified.
Fig. 36. Vertical section of the same femur; showing elongated lacunæ at *a*, and rounded at *b*.
Fig. 37. Lacunæ from the same section, more highly magnified.

# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF OPHIDIANS AND SAURIANS. Plate IX.

### Boa.

Trans.e Vert.l

Fig 2. 95 dias

Fig 1. 8 dias a

Fig 3. 440 dias

Fig 4. 95 d.

Fig 5. 440 dias

### Crocodile.

Trans.e Vert.l

Fig 6. 95 dias

Fig 7. 440 dias a

Fig 8. 95 dias

Fig 9. 440 dias

### Iguana.

Trans.e Vert.l

Fig 11. 95 dias

Fig 10. 3 dias

Fig 12. 440 dias

Fig 13. 95 dias

Fig 14. 440 dias

### Iguanodon.

Trans.e Vert.l

Fig 15. 95 dias

Fig 16. 440 d.

Fig 17. 95 dias

Fig 18. 440 dia.

### Draco Volans

Trans.e Vert.l

Fig 19. 95 dias

Fig 21. a b 95 dias

Fig 20. 440 dias

Fig 22. 440 dias

Fig 23. 440 dias

### Pterodactyle.

Trans.e Vert.l

Fig 24. 95 dias

Fig 26. 95 dias

Fig 27. 440 dias

Fig 25. 440 dias

Fig 28. 440 dias

Fig 29. 440 dias

### Monitor Lizard

Trans.e Vert.l

Fig 30. 95 dias

Fig 31. 440 dias

Fig 32. 95 dias

Fig 33. 440 dias

### Ichthyosaurus.

Trans.e Vert.l

Fig 34. 95 dias

Fig 35. 440 dias

Fig 36. 440 dias a

Fig 37. 440 dias a

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## PLATE X.

Fig. 1. Transverse section of the tibia of a Patagonian Penguin, *Aptenodytes Patachonica*.
Fig. 2. Portion of the same bone, more highly magnified.
Fig. 3. Vertical section of the same bone.
Fig. 4. Lacunæ of the same bone, more highly magnified.
Fig. 5. Transverse section of the humerus of an Albatros, *Diomedæa exulans*.
Fig. 6. Portion of the same section, more highly magnified.
Fig. 7. Vertical section of the humerus of an *Albatros*.
Fig. 8. Portion of the same section, more highly magnified.
Fig. 9. Transverse section of the femur of a Stork, *Ciconia alba*.
Fig. 10. Portion of the same section, more highly magnified.
Fig. 11. Vertical section of the femur of a *Stork*.
Fig. 12. Portion of the same section, more highly magnified.
Fig. 13. Transverse section of the femur of a Dinornis, *Dinornis giganteus*.
Fig. 14. Portion of the same section, more highly magnified.
Fig. 15. Vertical section of the femur of a *Dinornis*.
Fig. 16. Portion of the same section, more highly magnified.
Fig. 17. Transverse section of the femur of the Common Fowl, *Gallus domesticus*.
Fig. 18. Portion of the same section, more highly magnified.
Fig. 19. Vertical section of the femur of the *Common Fowl*.
Fig. 20. Portion of the same section, more highly magnified.
Fig. 21. Transverse section of the humerus of a Parrot, *Psittacus viridis*.
Fig. 22. Portion of the same section, more highly magnified.
Fig. 23. Vertical section of the humerus of the same *Parrot*.
Fig. 24. Portion of the same section, more highly magnified.
Fig. 25. Transverse section of the tibia of a Crow, *Corvus Corone*.
Fig. 26. Portion of the same section, more highly magnified.
Fig. 27. Vertical section of the tibia of the same *Crow*.
Fig. 28. Portion of the same section, more highly magnified.
Fig. 29. Transverse section of the humerus of a Condor, *Vultur gryphus*.
Fig. 30. Portion of the same bone, more highly magnified.
Fig. 31. Vertical section of the humerus of a *Condor*.
Fig. 32. Portion of the same section, more highly magnified.
Fig. 33. Transverse section of the femur of a large fossil bird from the London Clay of Sheppey.
Fig. 34. Portion of the same section, more highly magnified.
Fig. 35. Transverse section of the margin of the same fossil bone.
Fig. 36. A few of the lacunæ from the same specimen, more highly magnified.

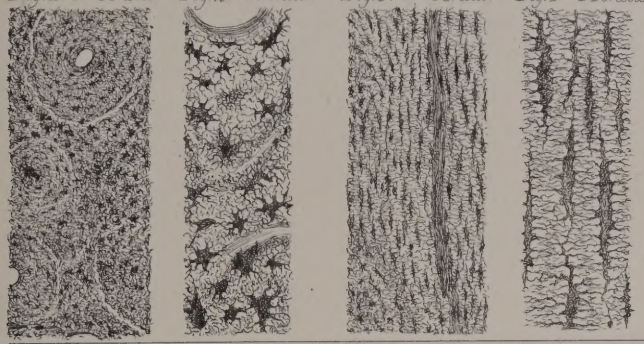
# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF BIRDS.

Plate. X.

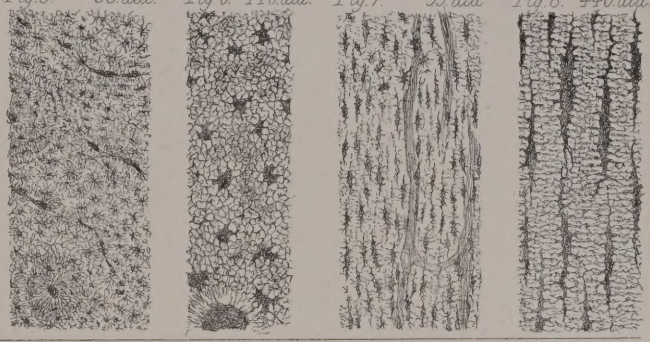
### Penguin.

Fig. 1. Trans.e 35 dias
Fig. 2. 440 dias
Fig. 3. Longi.l 35 dias
Fig. 4 440 dias



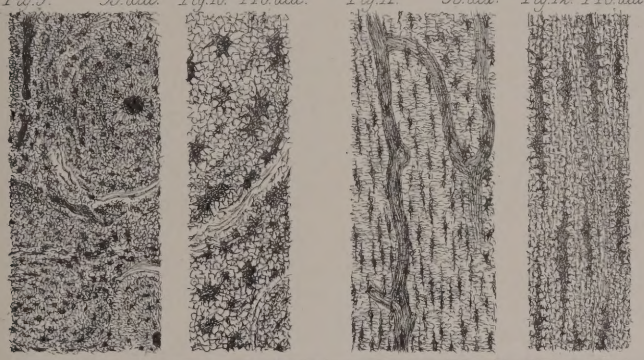
### Albatross.

Fig. 5. Trans.e 35 dias
Fig. 6. 440 dias
Fig. 7. Longi.l 35 dias
Fig. 8. 440 dias



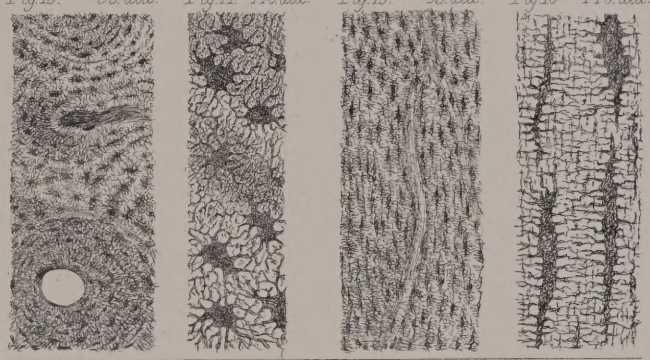
### Stork.

Fig. 9. Trans.e 35 dias
Fig. 10. 440 dias
Fig. 11. Longi.l 35 dias
Fig. 12. 440 dias



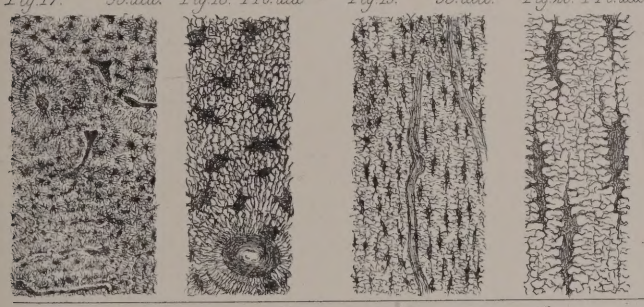
### Dinornis.

Fig. 13. Trans.e 35 dias
Fig. 14. 440 dias
Fig. 15. Longi.l 35 dias
Fig. 16. 440 dias



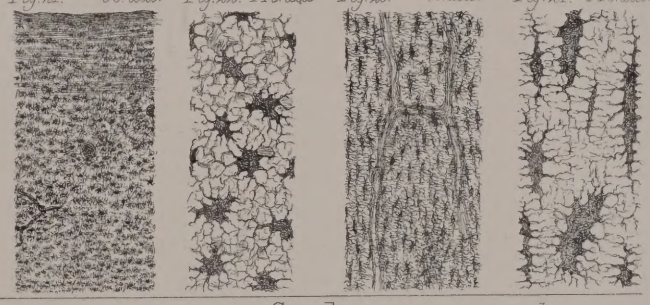
### Common Fowl.

Fig. 17. Trans.e 35 dias
Fig. 18. 440 dias
Fig. 19. Longi.l 35 dias
Fig. 20. 440 dias



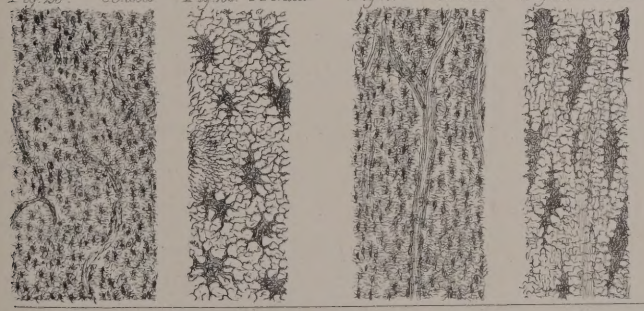
### Parrot.

Fig. 21. Trans.e 35 dias
Fig. 22. 440 dia
Fig. 23. Longi.l 35 dias
Fig. 24. 440 dias



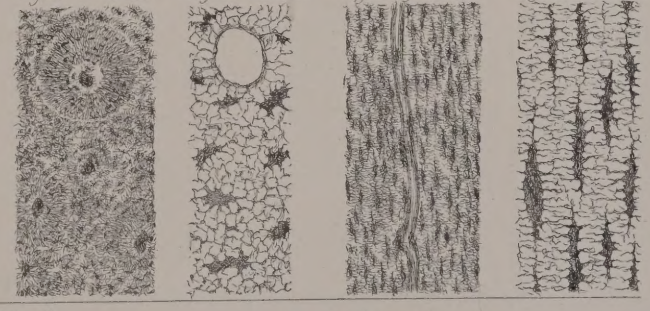
### Crow.

Fig. 25. Trans.e 35 dias
Fig. 26. 440 dias
Fig. 27. Longi.l 35 dias
Fig. 28. 440 dias



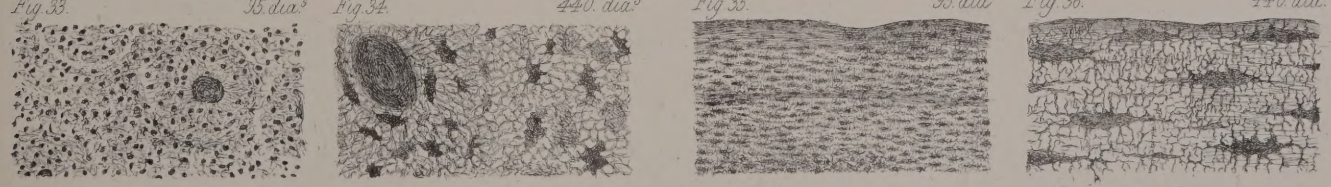
### Condor.

Fig. 29. Trans.e 35 dias
Fig. 30. 440 dias
Fig. 31. Longi.l 35 dias
Fig. 32. 440 dias



### Fossil Bird.

Fig. 33. Trans.e 35 dias
Fig. 34. 440 dias
Fig. 35. Trans.e 35 dia
Fig. 36. 440 dias



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## PLATE XI.

Fig. 1. Transverse section of the humerus of an Echidna, *Echidna Hystrix*.

Fig. 2. A portion of the same, more highly magnified.

Fig. 3. A vertical section of the humerus of an *Echidna*.

Fig. 4. A portion of the same, more highly magnified.

Fig. 5. A transverse section of the tibia of an Ornithorhynchus, *Ornithorhynchus paradoxus*.

Fig. 6. A portion of the same, more highly magnified.

Fig. 7. A vertical section of the tibia of an *Ornithorhynchus*.

Fig. 8. A portion of the same, more highly magnified.

Fig. 9. A transverse section of the radius of a Kangaroo, *Macropus major*.

Fig. 10. A portion of the same, more highly magnified.

Fig. 11. A longitudinal section of the radius of the same *Kangaroo*.

Fig. 12. A portion of the same, more highly magnified.

Fig. 13. A transverse section of the femur of a Rat, *Mus Rattus*.

Fig. 14. A portion of the same, more highly magnified.

Fig. 15. A longitudinal section of the femur of the same *Rat*.

Fig. 16. A portion of the same, more highly magnified.

Fig. 17. A transverse section of the femur of a Beaver, *Castor Canadensis*.

Fig. 18. A portion of the same, more highly magnified.

Fig. 19. A longitudinal section of the femur of the same *Beaver*.

Fig. 20. A portion of the same, more highly magnified.

Fig. 21. A transverse section of the femur of a Two-toed Sloth, *Cholœpus didactylus*.

Fig. 22. A portion of the same, more highly magnified.

Fig. 23. A vertical section of the femur of the same *Sloth*.

Fig. 24. A portion of the same, more highly magnified.

# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF MONOTREMATA, MARSUPIALIA, BRUTA, AND RODENTIA.

Plate XI.

Echidna

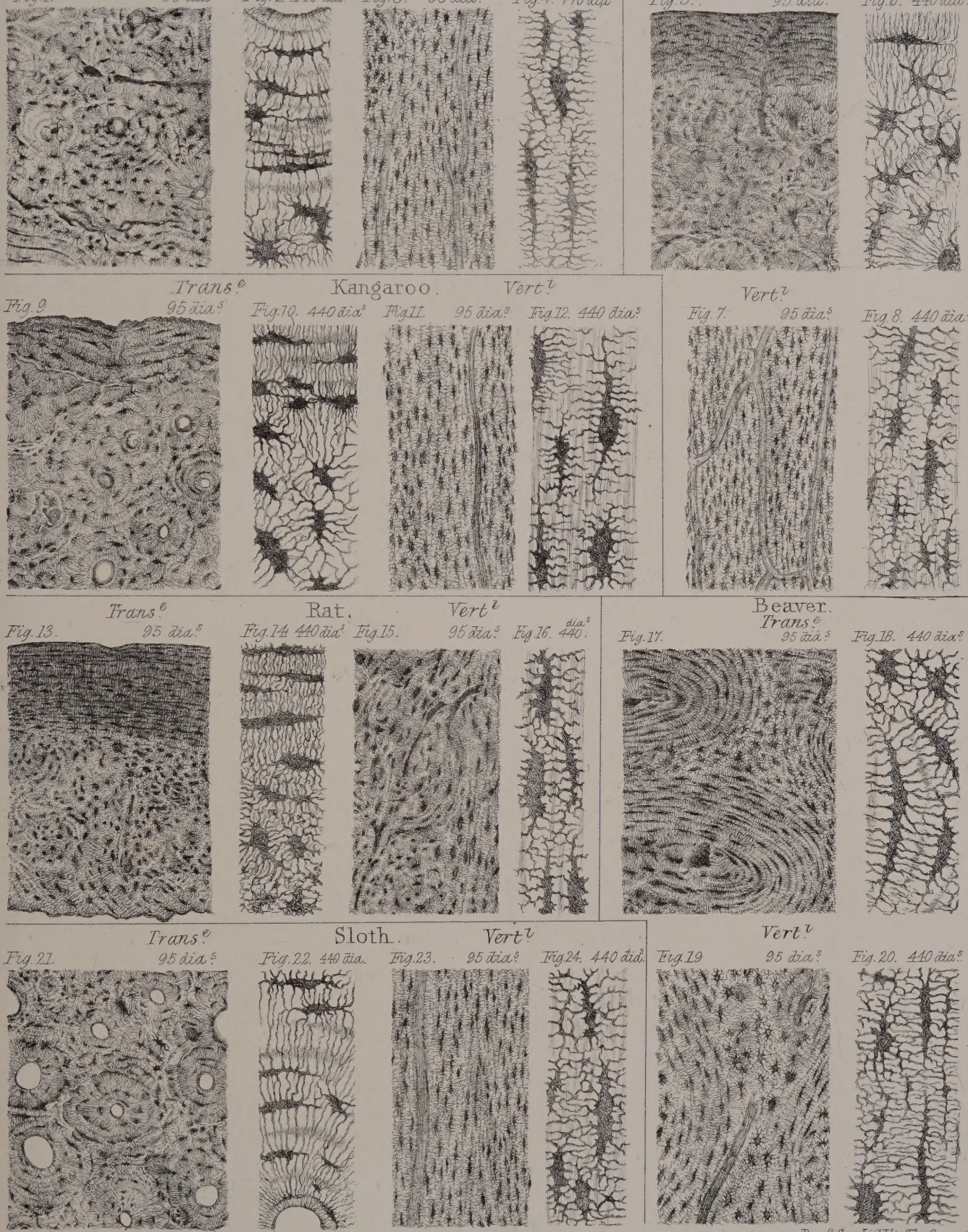
Ornithorhynchus.

Kangaroo.

Rat.

Beaver.

Sloth.

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## PLATE XII.

Fig. 1. A transverse section of the femur of a Mouse, *Mus musculus.*

Fig. 2. A portion of the same, more highly magnified.

Fig. 3. A longitudinal section of the femur of a *Mouse.*

Fig. 4. A portion of the same, more highly magnified.

Fig. 5. A transverse section of the femur of a Hedgehog, *Erinaceus europæus.*

Fig. 6. A portion of the same, more highly magnified.

Fig. 7. A vertical section of the femur of a *Hedgehog.*

Fig. 8. A portion of the same, more highly magnified.

Fig. 9. A transverse section of the humerus of a Mole, *Talpa europæa.*

Fig. 10. A portion of the same, more highly magnified.

Fig. 11. A vertical section of the humerus of a *Mole.*

Fig. 12. A portion of the same, more highly magnified.

Fig. 13. A transverse section of the humerus of a Bat, *Pteropus.*

Fig. 14. A portion of the same, more highly magnified.

Fig. 15. A longitudinal section of the humerus of a *Bat.*

Fig. 16. A portion of the same, more highly magnified.

Fig. 17. A transverse section of the tibia of an Elephant, *Elephas indicus.*

Fig. 18. A portion of the same, more highly magnified.

Fig. 19. A longitudinal section of the tibia of an *Elephant.*

Fig. 20. A portion of the same, more highly magnified.

Fig. 21. A transverse section of the humerus of a Hippopotamus, *Hippopotamus amphibius.*

Fig. 22. A portion of the same, more highly magnified.

Fig. 23. A longitudinal section of the humerus of a *Hippopotamus.*

Fig. 24. A portion of the same, more highly magnified.

# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF RODENTIA INSECTIVORA, CHEIROPTERA, AND PACHYDERMATA.

Plate XII.

Mouse.

Fig.1. Trans.e 95 dias

Fig.2. 240 dias

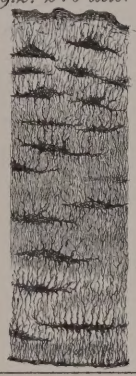
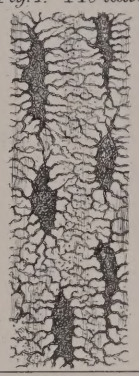


Fig.3. Vert.l 95 dias

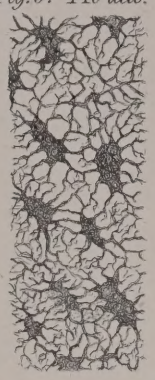
Fig.4. 440 dias



Hedgehog.

Fig.5. 95 dias

Fig.6. Trans.e 440 dias



Mole.

Fig.9. Trans.e 95 dias

Fig.10. 440 dias

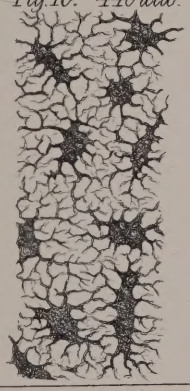


Fig.11. Vert.l 95 dias

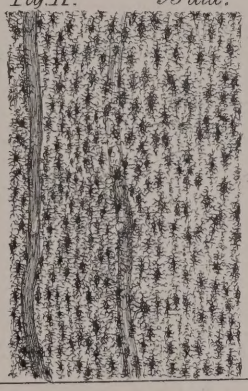


Fig.12. 440 dias

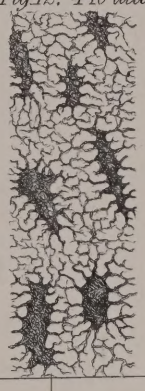
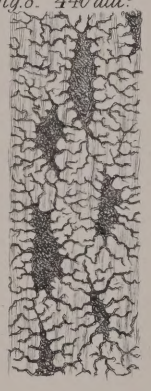


Fig.7. Vert.l 95 dias

Fig.8. 440 dias



Bat.

Fig.13. Trans.e 95 dias

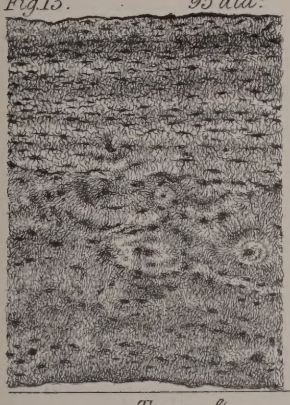


Fig.14. 440 dias

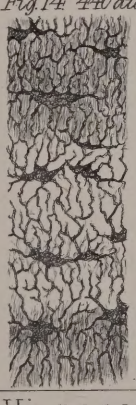
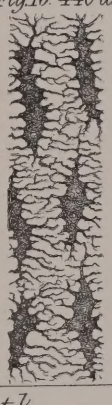


Fig.15. Vert.l 95 dias

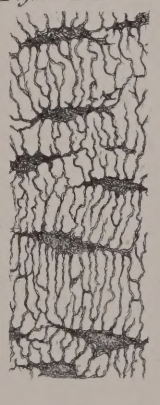
Fig.16. 440 dias



Elephant.

Fig.17. 95 dias

Fig.18. 440 dias



Hippopotamus.

Fig.21. Trans.e 95 dias

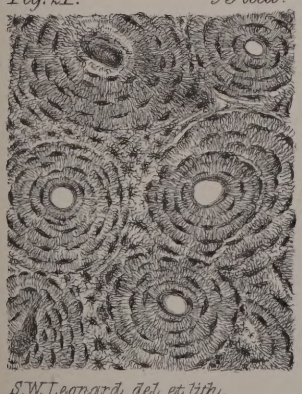


Fig.22. 440 dias

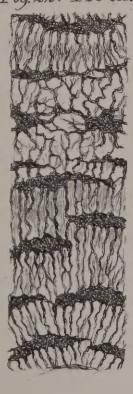


Fig.23. Vert.l 23 dias

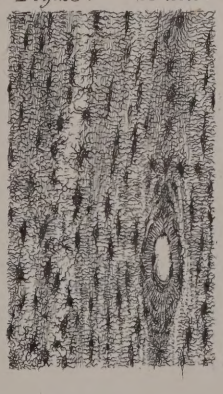


Fig.24. 440 dias

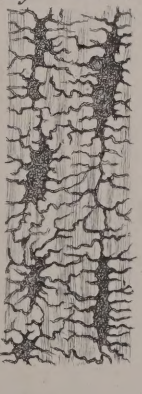


Fig.19. Vert.l 95 dias

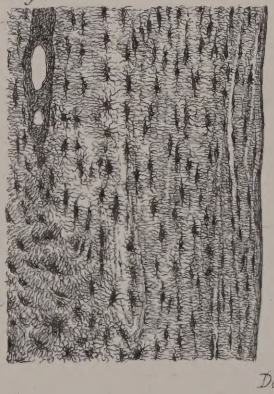
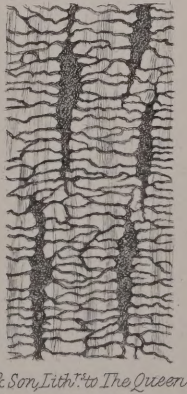


Fig.20. 440 dias



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## PLATE XIII.

Fig. 1. A transverse section of the rib of the Whalebone Whale, *Balæna mysticetus.*

Fig. 2. A portion of the same, magnified 95 diameters.

Fig. 3. A few of the lacunæ, more highly magnified.

Fig. 4. A vertical section of the rib of the *Whalebone Whale.*

Fig. 5. Lacunæ from the same, more highly magnified.

Fig. 6. A transverse section of the lower jaw of a Cachalot, *Physeter macrocephalus.*

Fig. 7. A portion of the same section, magnified 95 diameters.

Fig. 8. A few of the lacunæ, more highly magnified.

Fig. 9. A vertical section of the lower jaw of a *Cachalot,* magnified 95 diameters.

Fig. 10. A few of the lacunæ, more highly magnified.

Fig. 11. A transverse section of the lower jaw of a common Dolphin, *Delphinus Delphis.*

Fig. 12. A few of the lacunæ, more highly magnified.

Fig. 13. A longitudinal section of the lower jaw of the common *Dolphin.*

Fig. 14. A few of the lacunæ, more highly magnified.

Fig. 15. A transverse section of the lower jaw of a Porpoise, *Delphinus Phocæna.*

Fig. 16. A few of the lacunæ, more highly magnified.

Fig. 17. A longitudinal section of the rib of the *Porpoise.*

Fig. 18. A few of the lacunæ, more highly magnified.

Fig. 19. A transverse section of the rib of a Dugong, *Halicore indicus.*

Fig. 20. A portion of the same section, more highly magnified.

Fig. 21. A longitudinal section of the rib of the *Dugong.*

Fig. 22. Four of the lacunæ, more highly magnified.

Fig. 23. A transverse section of the rib of a Manatee, *Manatus americanus.*

Fig. 24. A portion of the same, more highly magnified.

Fig. 25. A longitudinal section of the rib of a *Manatee.*

Fig. 26. A few of the lacunæ, more highly magnified.

# HISTOLOGY OF ANIMALS.
## ENDO-SKELETON OF CETACEA.



Whalebone Whale.

Fig. 2. Trans.e 95 diam.s

Fig. 3. Vert.l 440 diam.s

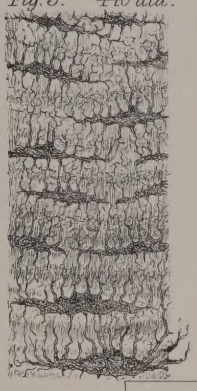


Fig. 4. 95 diam.s

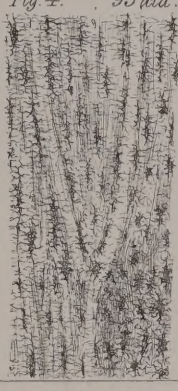
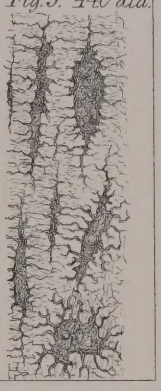


Fig. 5. 440 diam.s



Sperm Whale.

Fig. 6 Trans.e 12 diam.s

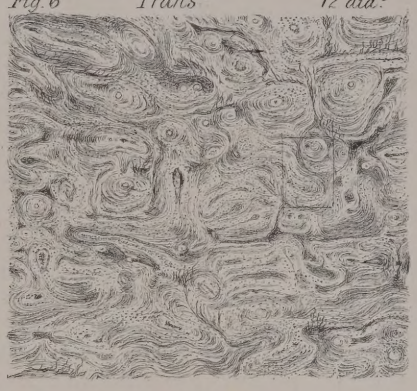
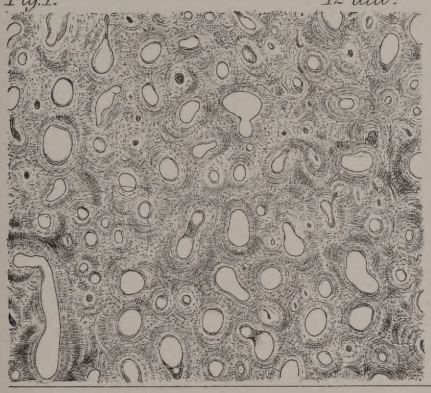


Fig. 1. Trans.e 12 diam.s



Sperm Whale.

Fig. 9. Vert.l 95 diam.s

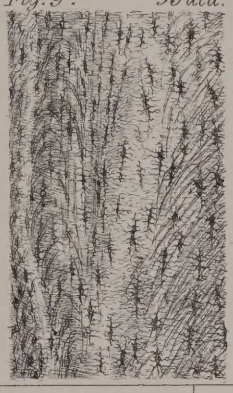


Fig. 10. 440 diam.s

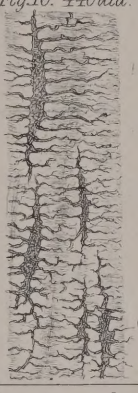


Fig. 7 Trans.e 95 diam.s

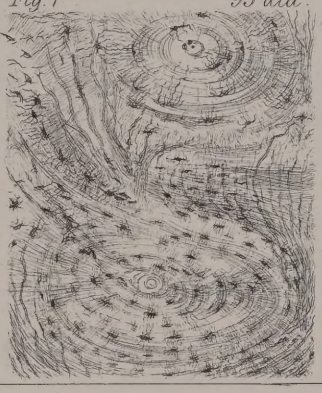
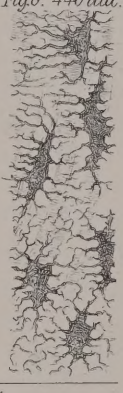


Fig. 8. 440 diam.s



Dolphin.

Fig. 11. Trans.e 95 diam.s

Fig. 12. Vert.l 440 diam.s

Fig. 13. 95 diam.s

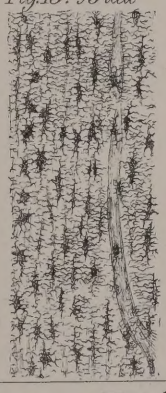


Fig. 14. 440 diam.s

Porpoise

Fig. 15. Trans.e 95 diam.s

Fig. 16. 440 diam.s

Fig. 17. Vert.l 95 diam.s

Fig. 18. 440 diam.s

Dugong

Fig. 19. Trans.e 95 diam.s

Fig. 20. Vert.l 440 diam.s

Fig. 21. 95 diam.s

Fig. 22. 440 diam.s

Manatee

Fig. 23. Trans.e 95 diam.s

Fig. 24. Vert.l 440 diam.s

Fig. 25. 95 diam.s

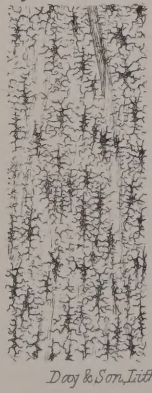
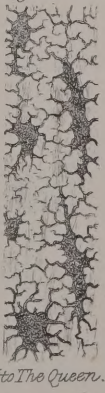


Fig. 26. 440 diam.s



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## PLATE XIV.

Fig. 1. A transverse section of the femur of an Ox, *Bos Taurus.*
Fig. 2. A portion of the same, more highly magnified.
Fig. 3. A longitudinal section of the femur of an *Ox.*
Fig. 4. A portion of the same, more highly magnified.
Fig. 5. A transverse section of the femur of a Sheep, *Ovis Aries.*
Fig. 6. A portion of the same, more highly magnified.
Fig. 7. A vertical section of the femur of a *Sheep.*
Fig. 8. A portion of the same, more highly magnified.
Fig. 9. A transverse section of the tibia of a Seal, *Phoca vitulina.*
Fig. 10. A portion of the same, more highly magnified.
Fig. 11. A longitudinal section of the tibia of a *Seal.*
Fig. 12. A portion of the same, more highly magnified.
Fig. 13. A transverse section of the radius of a Tiger, *Felis Tigris.*
Fig. 14. A portion of the same, more highly magnified.
Fig. 15. A longitudinal section of the radius of a *Tiger.*
Fig. 16. A portion of the same, more highly magnified.
Fig. 17. A transverse section of the tibia of a Polecat, *Putorius Furo.*
Fig. 18. A portion of the same, more highly magnified.
Fig. 19. A longitudinal section of the tibia of a *Polecat.*
Fig. 20. A portion of the same, more highly magnified.
Fig. 21. A transverse section of the femur of a Bear, *Ursus maritimus.*
Fig. 22. A portion of the same, more highly magnified.
Fig. 23. A longitudinal section of the femur of a *Bear.*
Fig. 24. A portion of the same, more highly magnified.
Fig. 25. A transverse section of the humerus of *Macacus Rhesus.*
Fig. 26. A portion of the same, more highly magnified.
Fig. 27. A longitudinal section of the humerus of *Macacus Rhesus.*
Fig. 28. A portion of the same, more highly magnified.
Fig. 29. A transverse section of the radius of an Orang-utan, *Pithecus Satyrus.*
Fig. 30. A portion of the same, more highly magnified.
Fig. 31. A longitudinal section of the humerus of an *Orang-utan.*
Fig. 32. A portion of the same, more highly magnified.
Fig. 33. A transverse section of the radius of a Chimpanzee, *Troglodytes niger.*
Fig. 34. A portion of the same, more highly magnified.
Fig. 35. A longitudinal section of the radius of a *Chimpanzee.*
Fig. 36. A portion of the same, more highly magnified.

# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF RUMINANTIA, CARNIVORA, AND QUADRUMANA. Plate XIV.

Ox.

Fig.1. Trans.e 95 dias

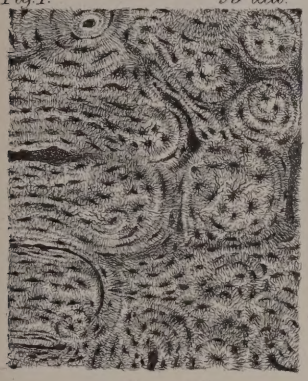


Fig.2. 440 dia

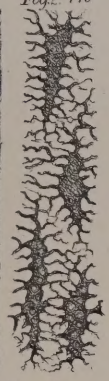
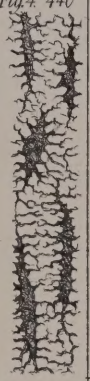


Fig.3. Vert.l 95 dias

Fig.4. 440 dias



Sheep.

Fig.5. Trans.e 95 dias

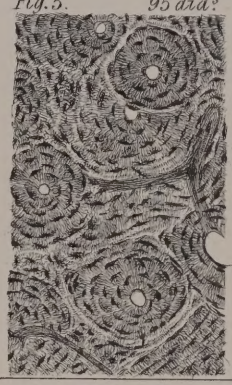


Fig.6. 440 dias

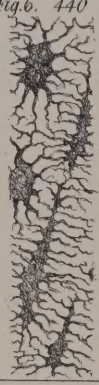
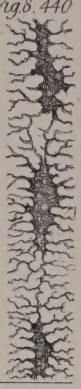


Fig.7. Vert.l 95 dias

Fig.8. 440 dias



Seal.

Fig.9. Trans.e 95 dias

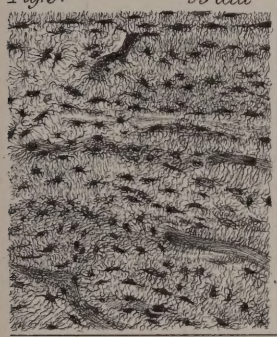


Fig.10. 440 dias

Fig.11. Vert.l 95 dias

Fig.12. 440 dias

Tiger.

Fig.13. Trans.e 95 dias

Fig.14. 440 dias

Fig.15. Vert.l 95 dias

Fig.16. 440 dias

Polecat.

Fig.17. Trans.e 95 dias

Fig.18. 440 dias

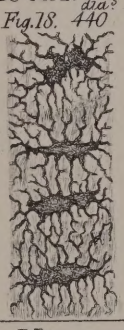


Fig.19. Vert.l 95 dias

Fig.20. 440 dias

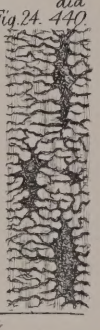
Bear.

Fig.21. Trans.e 95 dias

Fig.22. 440 dia

Fig.23. Vert.l 95 dias

Fig.24. 440 dias



Macacus.

Fig.25. Trans.e 95 dias

Fig.26. 440 dias

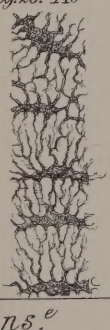


Fig.27. Long.l 95 dias

Fig.28. 440 dia

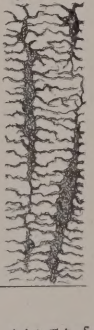
Orang-utan.

Fig.29. Trans.e 95 dias

Fig.30. 440 dia

Fig.31. Long.l 95 dias

Fig.32. 440 dias



Chimpanzee.

Fig.33. Trans.e 95 dias

Fig.34. 440 dias

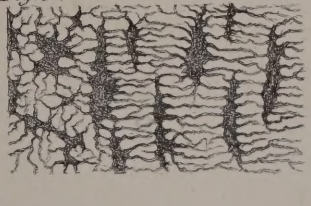


Fig.35. Vert.l 95 dias

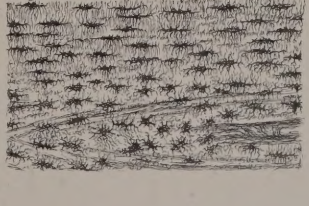
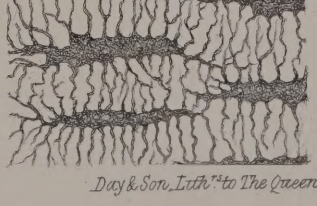


Fig.36. 440 dias



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## PLATE XV.

Fig. 1. A vertical section of the left parietal bone of an adult *Human subject.*

Fig. 2. A portion of the outer table of the same section, more highly magnified.

Fig. 3. A portion of the inner table of the same section, more highly magnified.

Fig. 4. A few of the lacunæ from the last specimen, more highly magnified.

Fig. 5. A transverse section of the rib of an adult *Human subject,* magnified 95 diameters.

Fig. 6. A transverse section of the rib of an adult *Human subject* of the natural size.

Fig. 7. A few of the lacunæ from the same specimen, magnified 440 diameters.

Fig. 8. A vertical section of the frontal bone of an adult *Human subject,* magnified 200 diameters.

Fig. 9. The same section of the natural size.

Fig. 10. A vertical section of the trapezoid bone of the wrist of an adult *Human subject.*

Fig. 11. A vertical section of the olecranon process of the ulna of an adult *Human subject.*

Fig. 12. The same section of the natural size.

Fig. 13. A transverse section of the femur of an adult *Human subject,* in which both lacunæ and canaliculi are filled with earthy matter.

Fig. 14. A transverse section of an hypertrophied tibia of an adult *Human subject,* showing the laminæ.

Fig. 15. A transverse section of an atrophied femur of an adult *Human subject,* showing the laminæ.

Fig. 16. A transverse section of the femur of an Egyptian Mummy. *a.* An Haversian system, impregnated with bituminous matter.

Fig. 17. A transverse section of the tibia of an adult *Human subject.* *a.* Haversian space.

Fig. 18. A portion of the femur of an adult *Human subject,* showing the laminæ under a high power.

Fig. 19. A longitudinal section of the cannon bone of a fossil *Horse,* in which the canals and lacunæ are filled with brown colouring matter.

# HISTOLOGY OF ANIMALS.
## ENDO-SKELETON OF MAMMALIA.

Plate XV

Fig. 1. 15 dias

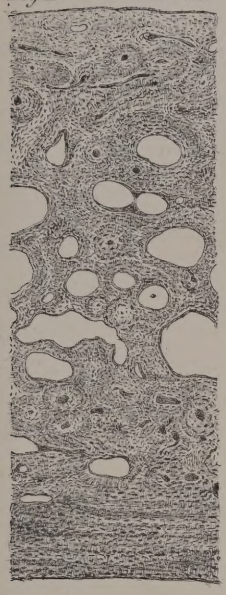


Fig. 2 95 dias

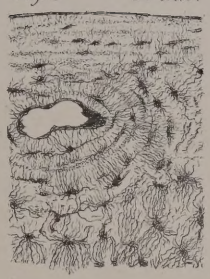


Fig. 3. 95 dias

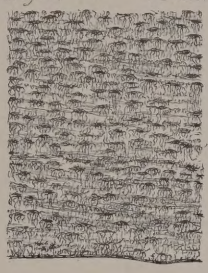


Fig. 4. 440 dias

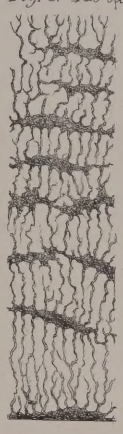


Fig. 5. 95 dias

Fig. 7. 440 dias

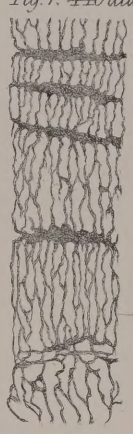


Fig. 8. 200 dias

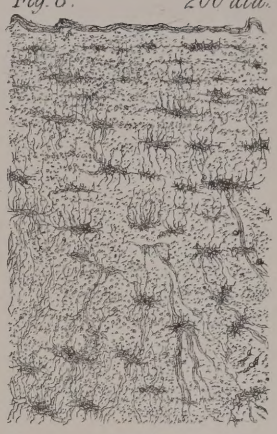
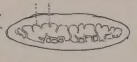
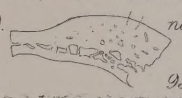


Fig. 6.



nat. size

Fig. 9.



nat. size

Fig. 11. 200 dias

a

b

c

Fig. 12.

nat. size

Fig. 13. 95 dias

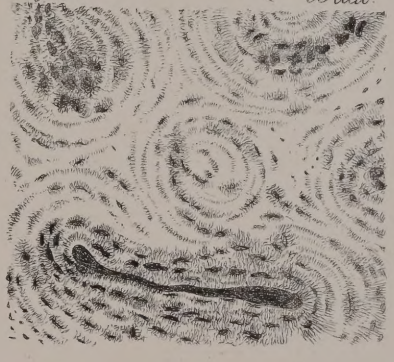
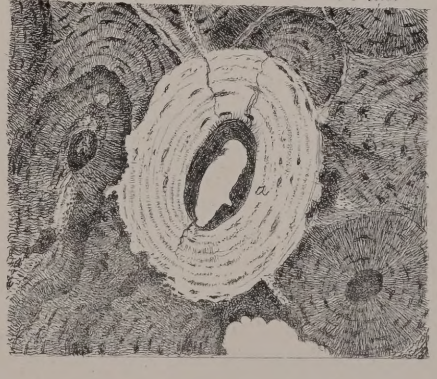


Fig. 10. 200 dias

Fig. 16. 95 dias



a

Fig. 14. 95 dias

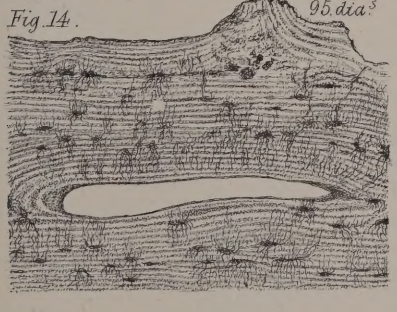
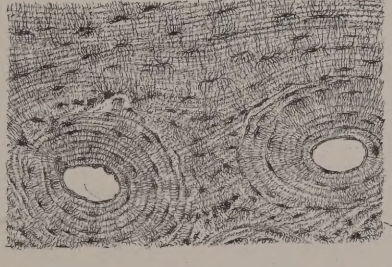


Fig. 15. 95 dias



a

Fig. 19. 95 dias

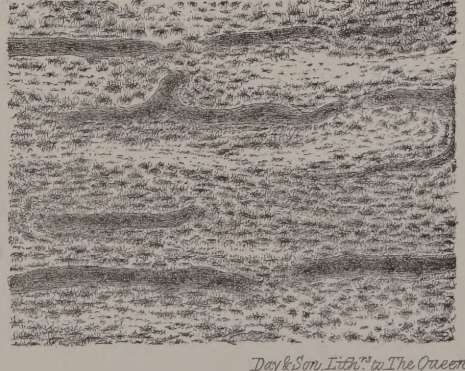
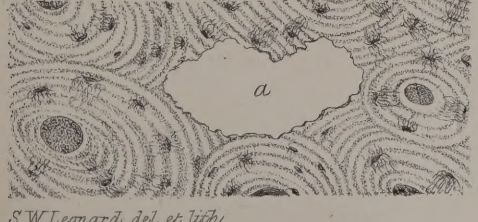
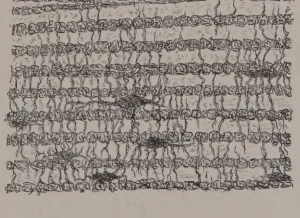


Fig. 17.



a

Fig. 18. 440 dias



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## PLATE XVI.

Fig. 1. A transverse section of the femur of an adult *Human subject*. *a*. Circumferential laminæ. *b b*. Large Haversian canals. *c c*. Smaller Haversian canals.

Fig. 2. A portion of the same specimen, more highly magnified. *a*. An Haversian interspace.

Fig. 3. A vertical section of the femur of an adult *Human subject*, showing the course of the Haversian canals.

Fig. 4. A portion of the same specimen, more highly magnified. *a*. Laminæ arranged parallel with the walls of an Haversian canal. *b*. Laminæ arranged in curves.

Fig. 5. Three of the lacunæ from the same specimen, magnified 1200 diameters. *a a*. Osseous granules in the matrix.

Fig. 6. A portion of the specimen, represented by fig. 4, magnified 440 diameters. *a*. An Haversian canal showing the orifices of the canaliculi.

Fig. 7. A portion of the cranium of a *Bat*, showing the osseous granules.

Fig. 8. A vertical section of the epiphysis of the humerus of a fœtal *Wolf*, showing the osseous granules amongst the cartilage-cells.

Fig. 9. A vertical section of a fibrous tumour, showing granules amongst the fibres.

Fig. 10. A transverse section of the tibia of a young *Pig*, which had been fed on madder.

Fig. 11. Blood-vessels of the periosteum.

Fig. 12. A vertical section of the tibia of a *Rabbit*, showing the blood-vessels in the Haversian canals. *a*. Old bone of the shaft. *b*. New bone, developed after injury to the periosteum.

Fig. 13. A vertical section of the humerus of a *Calf*, showing blood-vessels in the Haversian canals.

# HISTOLOGY OF ANIMALS.
## ENDO-SKELETON OF MAMMALIA.

Plate XVI

Fig. 1. 20 dia.s

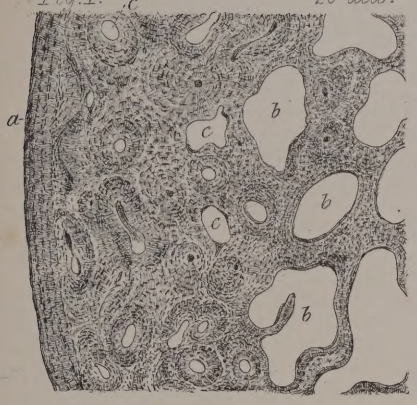



Fig. 3. 20 dia.s

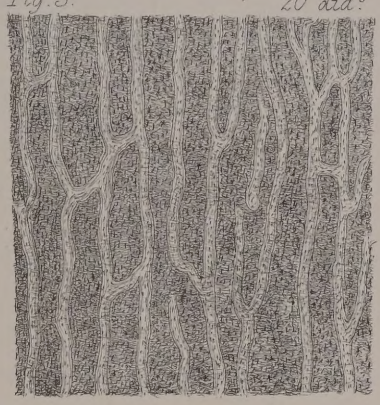


Fig. 5. 1200 dia.s

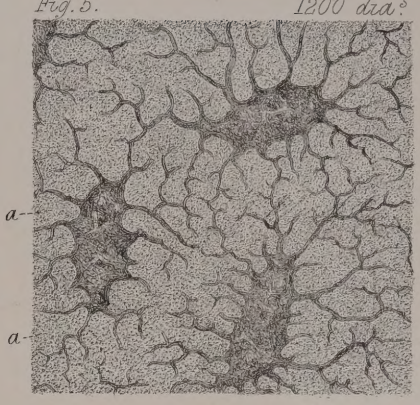



Fig. 2. 95 dia.s

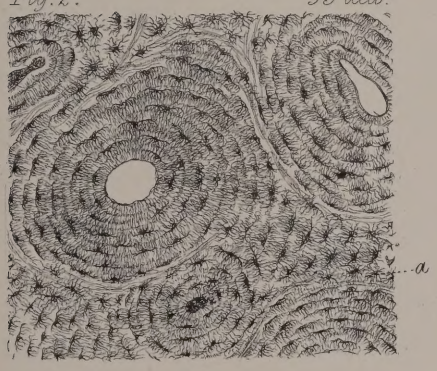



Fig. 4. b 95 dia.s

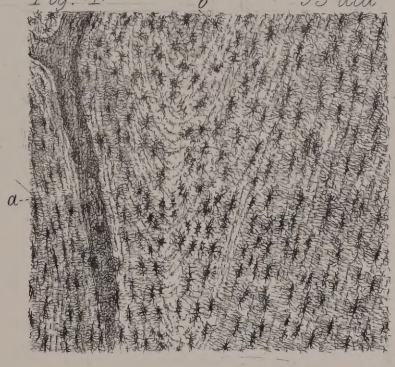



Fig. 6. a 440 dia.s

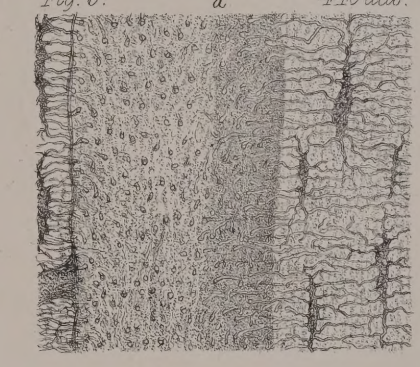


Fig. 7. 400 dia.s

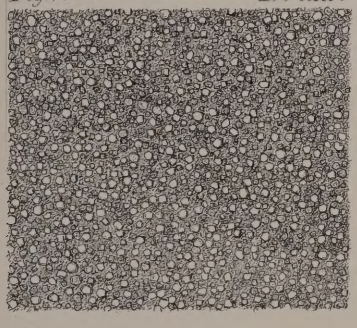


Fig. 8. 130 dia.s

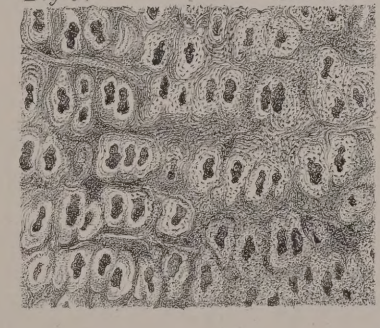


Fig. 9. 250 dia.s

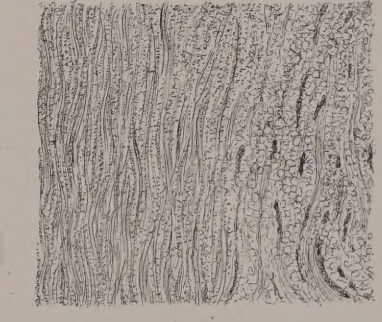


Fig. 10. 45 dia.s

Fig. 11. 20 dia.s

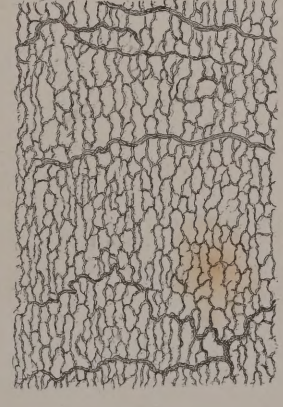


Fig. 12. 20 dia.s

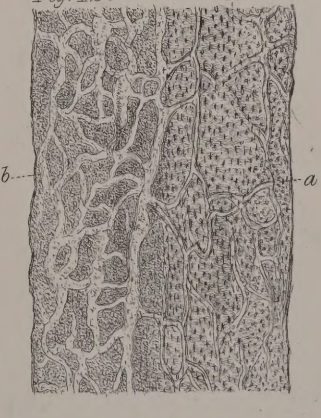
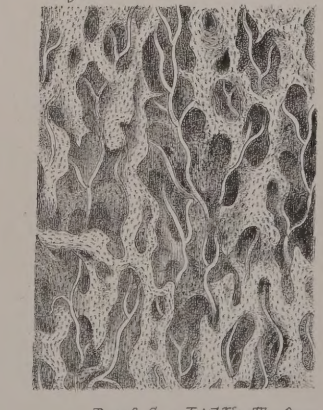



Fig. 13. 20 dia.s



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## PLATE XVII.

Fig. 1. A transverse section of the clavicle of an adult *Human subject.*

Fig. 2. A longitudinal section of the same bone.

Fig. 3. A transverse section of the femur of an Ostrich, *Struthio camelus.*

Fig. 4. A longitudinal section of the same bone.

Fig. 5. A transverse section of the humerus of a Turtle, *Chelone Mydas.*

Fig. 6. A longitudinal section of the same bone.

Fig. 7. A longitudinal section of the lower jaw of a Conger Eel, *Muræna conger.* Preparation B a 155.

Fig. 8. A longitudinal section of a bone of the cranium of a Menopome, *Menopoma alleghaniense.* Preparation B b 27.

Fig. 9. A longitudinal section of a bone of the cranium of a Siren, *Siren lacertina.* Preparation B b 17.

# BONE.



Fig. 1 *Human.* ( Transverse ) 95 dia.s

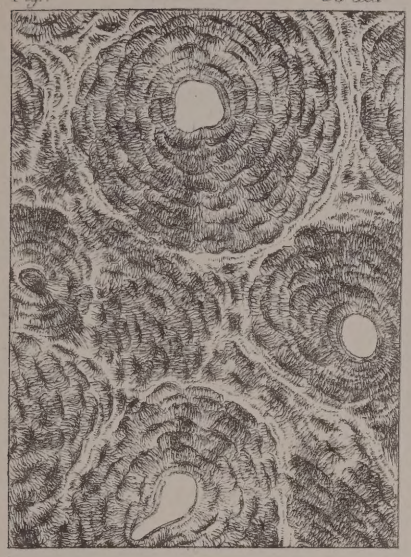


Fig. 2 *Human.* ( Longitudinal ) 95 dia.s

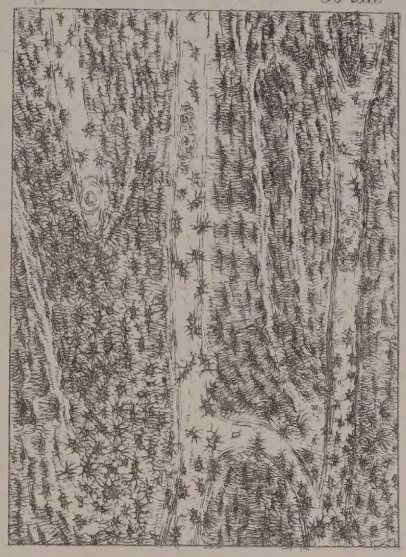


Fig. 3. *Ostrich.* ( Transverse ) 95 dia.

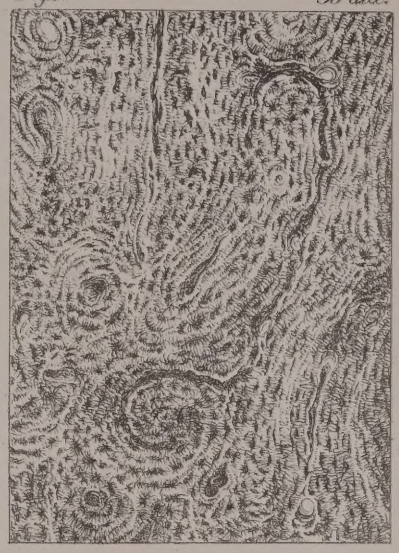


Fig. 4. *Ostrich* ( Longitudinal ) 95. dia.s

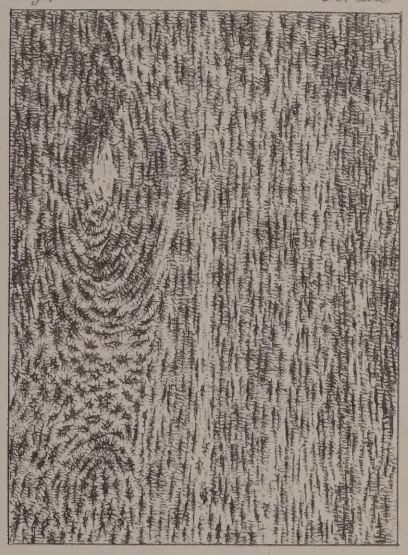


Fig. 5 *Turtle.* ( Longitudinal ) 95 dia.s

Fig. 6. *Turtle* ( Transverse ) 95 dia.s

Fig. 7. *Conger Eel* ( Longitudinal ) 95 dia.s

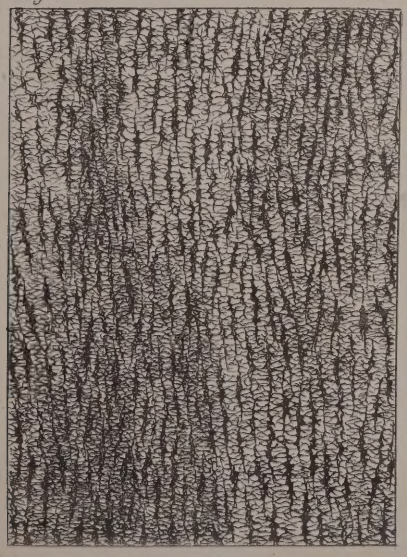


Fig. 8. *Menopome.* ( Longitudinal ) 95 dia.s

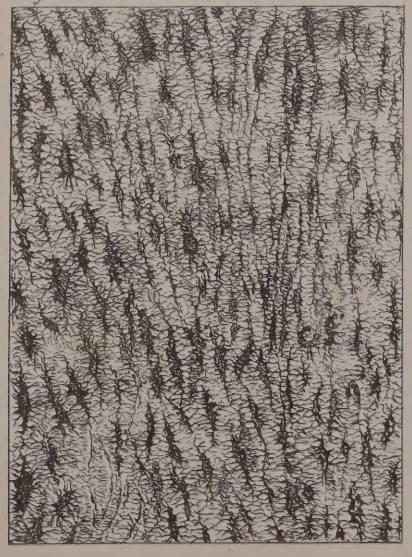
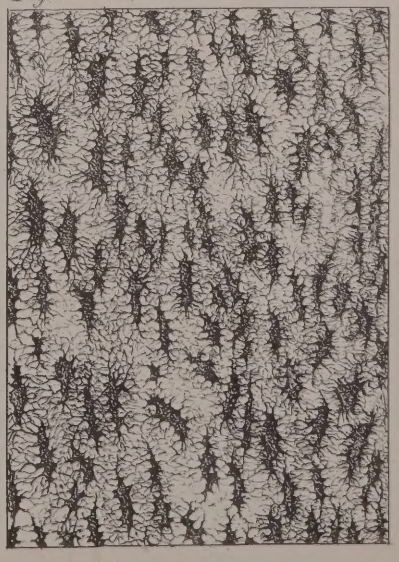


Fig. 9 *Siren.* ( Longitudinal ) 95 dia.s



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100th of an Inch

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## PLATE XVIII.

Fig. 1. A transverse section of the humerus of a Spider Monkey, *Ateles paniscus*.

Fig. 2. A portion of the same section, more highly magnified.

Fig. 3. Three of the peculiar lacunæ, from a longitudinal section of the same bone.

Fig. 4. Lacunæ of the Three-toed Sloth, *Bradypus tridactylus*. Preparation B d 68.

Fig. 5. Lacunæ of the Mylodon, *Mylodon robustus*. Preparation B d 75.

Fig. 6. A portion of the humerus of a Short-tailed Monkey, *Macacus Rhesus*, showing the peculiar cell-like markings between the canaliculi.

Fig. 7. A portion of the same section, more highly magnified.

Fig. 8. A transverse section of Human bone, impregnated with crystalline material.

Fig. 9. Another portion of the same section, in which the laminated structure is well displayed.

Fig. 10. Lacunal cells. *a*. Outer cell-wall. *b*. Granular cell. *c*. Nucleus of granular cell. *d d*. Granular cell in process of development into a lacuna. *e*. Lacunæ after the disappearance of the cell-wall. *f*. Lacunæ surrounded by osseous granules.

Fig. 11. A portion of the animal basis of the bone of a *Mastodon*, showing the lacunæ and the little pits in which the osseous granules were imbedded.

Fig. 12. Circumferential laminæ of a Human tibia, showing the development of laminæ from osteal cells. *a*. Osteal cells. *b*. Compound cell, the origin? of the osteal cells. *c*. Laminæ formed of osteal cells: after Tomes and De Morgan.

Fig. 13. A transverse section of the base of the antler of a Fallow-Deer, *Cervus dama*.

Fig. 14. A portion of the same bone, more highly magnified. *a a*. Haversian canals surrounded by structureless bone.

Fig. 15. Transverse section of a Human femur, deprived of its animal matter.

Fig. 16. A corresponding section of the same bone, deprived of its earthy matter.

# HISTOLOGY OF ANIMALS.

## ENDO-SKELETON OF MAMMALIA.

Plate XVIII.

Fig. 1. 50 dia.s

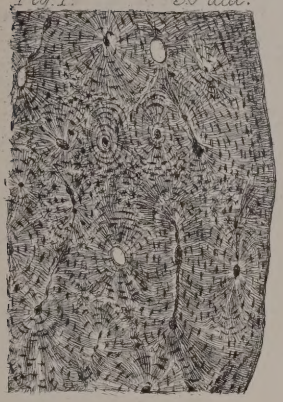


Fig. 2. 250 dia.

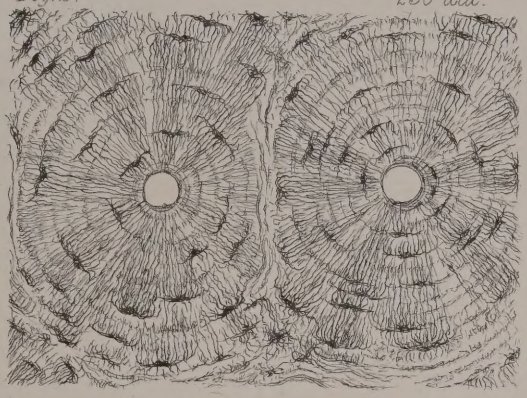


Fig. 3. 440 dia.s

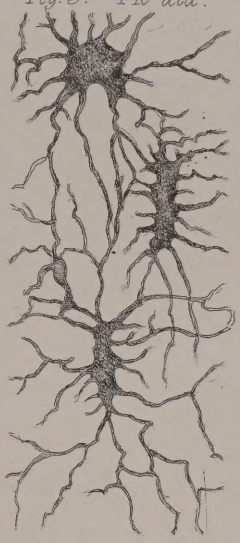


Fig. 4. 440 dia.s

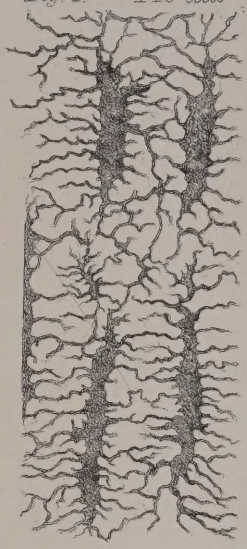


Fig. 6. 250 dia.s

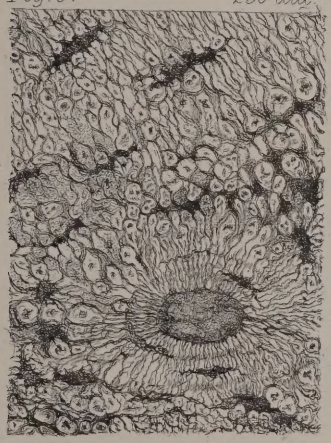


Fig. 7. 440 dia.s

Fig. 10

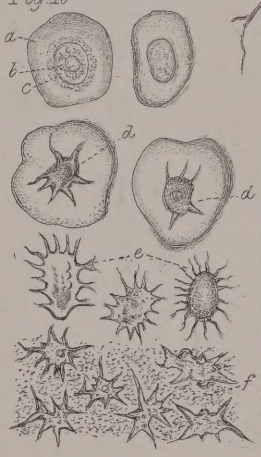



Fig. 11. 440 dia.s

Fig. 5. 440 dia.s

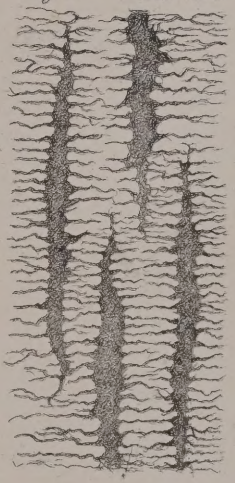


Fig. 8. 130 dia.s

Fig. 9. 130 dia.s

Fig. 12. 800 dia.s

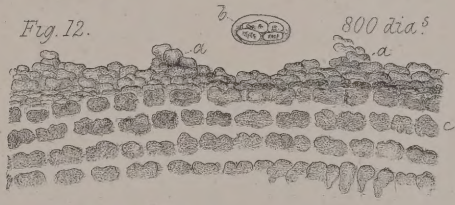



Fig. 13. 50 dia.s

Fig. 14. 250 dia.s

Fig. 15. 130 dia.s

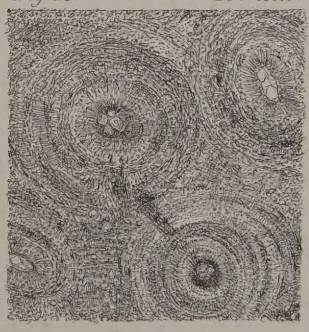
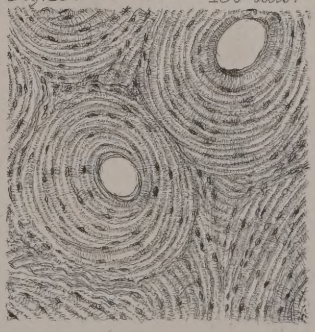


Fig. 16. 130 dia.s



S. W. Leonard, del. et lith.

Day & Son, Lith.rs to The Queen.

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